

CONVERSATIONS
ON THE
Plurality of Worlds.

Robt Boyle
BY
M. DE FONTENELLE.

TRANSLATED

W. M. Robertson

From the last Edition of the FRENCH.

ILLUSTRATED

With NOTES, collected from the most
approved Writers; and containing all the late
Discoveries in Astronomy.

TOGETHER

With COPPER-PLATES.

The WORLDS were framed by the Word of GOD.

HEB. xi. 3.

DUBLIN:

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X

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P R E F A C E



P R E F A C E.

By the EDITOR of this *Dublin* EDITION.

AS a new translation of Fontenelle's *Plurality of Worlds* has lately appeared in London, it seems necessary to give our reasons, why it was not thought proper rather to re-print the same here, than to be at the trouble of preparing another for the press.

Upon a careful perusal of that work, the style was observed to be, in general, mean, and spiritless: and though it came nearer to the sense of the original, in several places, than the former translations; yet, in the above-mentioned respects, it was found to be much inferior to them; and, therefore, less proper for the perusal of young persons. Besides, though the editor had taken in many omissions, which were in the old translations; yet he had made some himself, particularly Fontenelle's description of the *Tychonic system*, at the end of the first evening's conversation, which the author refers to in a subsequent one.

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The additions, which, in the title page, are said to be extracted from the best authors, were found to be equally as proper, for the most part, to be added to any other work of natural philosophy, as to this; many of them being too speculative and mathematical for the generality of the readers, for whom Fontenelle designed these discourses: and as they are injudiciously placed, as so many separate digressions, at the end of each evening's conversation, without any immediate connection with the work, or order among themselves; they only serve to swell the volume to little purpose, and rather to break in on the chain of reasoning used by the author in the text, than to illustrate his meaning, or afford the reader a representation, in one view, of the difference between the Cartesian hypothesis, and the true system of our illustrious Newton. We shall say no more of this performance; but, for a further account of it, refer our readers to the Monthly Review for July, 1760.

The present edition has been carefully compared with the last one published in French, which had been revised by the author; the omissions and deficiencies of the former translations have been added; and the sense corrected, in some hundreds of places, from the original; as may be seen, by any person, who will be at the pains of comparing the present and former translations with the original French.

Besides, in order to illustrate the work, the modern discoveries in natural philosophy and astronomy,



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tronomy, are placed in opposition to the Cartesian system maintained by the author; a number of notes, in imitation of those of Dr. Clarke on Rohault's physics, are subjoined, at the bottom of each page; and, for their further explication, several figures, engraved in copper, have been added; an account of which may be seen at the end of the table of contents. There are also annexed, a complete index, two papers of Mr. Addison on the subject of this work, and Milton's Hymn to the Creator; these three last being judged very proper lessons for young persons.

The notes are chiefly collected from the following writers; the figures shew where they are cited in this work.

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The editor would endeavour to recommend this little work to those, whose province it is to undertake the education of youth. Much may be found in the original, and, he will venture to say,
 not

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not a few things also in the notes, to enlarge their ideas, and inform their minds : For, as a celebrated poet says,

*There dwells a noble pathos in the skies,
Which warms our passions, proselytes our hearts.*

Night Thoughts, Numb. IX.

To which permit him to subjoin, a more ancient authority, he means CICERO, who requires, in his perfect orator, “ some skill in the nature
“ of the heavenly bodies ; because, his mind will
“ become,” says he, “ more extensive and un-
“ confined ; and when he descends to treat of
“ human affairs, he will both think and write in
“ a more exalted and magnificent manner.”

The frothy performances, which daily fall into the hands of youth of both sexes, and which have been published, in such numbers, for years past, must have had very ill effects, both on their minds and manners : for the generality of our modern romances, novels, and even too many of our theatrical entertainments, are commonly calculated to inflame a wanton fancy ; or, if conducted with so much modesty, as not to debauch the affections, they pervert the judgment, and corrupt the taste. By their incredible adventures, their extravagant parade of gallantry, and their characters, widely different from truth and nature ; they inspire foolish conceits, beget idle expectations, introduce a disgust of genuine history, and indispose their admirers to acquiesce in the decent civilities, or to relish the sober satisfaction of common life.

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To induce youth to despise such kinds of entertainments, nothing can contribute more, than instructing them in the knowledge of some of the magnificent works of nature ; and, indeed, it ought to be the design of every person, to whose care their education is committed, to take every method, to cultivate in them a dislike of such unimproving reading ; and, at the same time, to lay before them such books, as are most proper to form their minds, and which, treasured up in their memory, will always afford them such sublime knowledge, as they must reflect upon with new pleasure and satisfaction, every time they indulge themselves to pursue such rational entertainments.



THE



• T H E

Author's Preface.

I AM nearly in such a situation as CICERO was, when he attempted to discourse of philosophical subjects in the Latin language, which till then, had been only treated of in the Greek. He informs us, that it was said his works would be wholly useless, because those who loved philosophy, would, with pleasure, give themselves the pains to search for her in the Greek treatises, neglecting afterwards such Latin books as treated on that subject, because they were not originals; and, that those who had not a taste for philosophy, would not search for her either in Latin or Greek authors.

To this he answers, that the contrary would happen; that those who were not philosophers, would be tempted to become such by the facility of reading Latin books; and that those who were already such by reading Greek authors, would be desirous of seeing how the same subjects were executed in Latin.

CICERO

CICERO had reason to argue thus; the excellency of his genius, and the great reputation that he had before acquired, warranted to him the success of those new sorts of works, which he gave to the public; but as for me, I am far from having the same reasons to be confident of gaining fame by a design similar to his. I have been desirous to treat of philosophy in a stile that is not philosophical: I have endeavoured to come up to a certain point, without appearing too formal for people of fashion, or too trifling for the learned. But, if it should be objected to me as to CICERO, that such a work is neither proper for the learned, as it can teach them nothing new; nor for those who are ignorant, as they will not be taught; nor yet for people of pleasure, who have not any desire to learn; I shall not chuse to answer in the manner he did. It may very easily happen, that in searching for a medium, wherein philosophy might please all the world, I have found out one which will not suit with any body; a proper medium is very difficult to preserve; and, I believe, I shall never desire to give myself a second trouble of this kind.

I ought to inform those who read this work, and who have some knowledge of natural philosophy, that I have, by no means, attempted to instruct them, but only to divert them, by presenting them, in a manner something more agreeable and pleasing, that which they already knew, and have seen in a graver dress; and I inform those to whom these subjects are new, that

I thought,

I thought, by this means I might instruct and divert them at the same time. The first will act contrary to my intention, if they search here merely for utility; and the second, if they expect only the agreeable and pleasing.

I shall not farther amuse myself by saying, that I have chosen in all philosophy, a subject the most capable of exciting the curiosity of the reader. To me it appears, that nothing ought more to interest us, than to know how this world is made which we inhabit; and whether there be other worlds like this, which are also inhabited: but, after all, every one may carry their enquiries as far as they please. Those who have thoughts to lose, may throw them away upon these sorts of subjects; but every body is not properly qualified to spend them on these kind of enquiries.

I have introduced into these discourses a lady to be instructed, who is supposed had never before any acquaintance with these subjects. I imagined such a fiction would serve me, and render the work far more agreeable, and encourage ladies to read, by the example of one of their own sex, who being wholly unacquainted with the sciences, yet easily understood that which was said, and arranged in her mind the ideas of vortexes*, and worlds without confusion. Why should there not be women who might as readily conceive the meaning of such things as this imaginary Marchioness,

* The term vortex, as here used, is explained in the succeeding notes.

chioness, whose conceptions were only natural, and such as she could not well avoid having?

Indeed, she applied herself a little to the subject; but, what is the application here required? It is not by the force of meditation to penetrate into an obscure subject, or one obscurely explained. It is only not to read further without first forming a distinct idea of the thing read. I only demand of the ladies, for all this system of philosophy, the same application that they would give to the romance of the princess of Cleves, if they would understand the plot, and know all the beauty of it. It is true, that the ideas of this book are less familiar to many of the fair sex than those of the princess of Cleves; but they are not more obscure; and, I am certain that, on a second reading, there are very few things therein will escape any one of the sex.

As I have not pretended to build a system in the air without any foundation, I have employed true philosophical reasoning, and I have made use of as much of it as was necessary: it falls out very happily, that the philosophical notions, belonging to this subject, are of themselves very agreeable and entertaining; and, at the same time, that they satisfy our reason, they present to the imagination, images which please as much as if they were expressly formed for pleasing only.

When I have found some fragments, which were not wholly of this kind, I have given them a peculiar dress. VIRGIL hath made use of such arts in his Georgics, where he ornaments his subject,

ject, which is always dry, with frequent digressions, and those are always very agreeable. OVID hath even done as much in his Art of Love, although his subject was far more pleasing, than any thing it was possible for him to introduce. In fact, he thought it would be very tiresome, always to treat of one and the same thing, though the subject was precepts of gallantry. But, for my part, though I had more occasion than he of assistance from digressions, yet, however, I have made use of them but sparingly: I have authorized them, by the natural liberty of conversation: I have only inserted them in those places where they might be naturally expected: I have put the greatest part of them in the beginning of the work; because, at first the mind is not sufficiently acquainted with the principal ideas which are presented to it: in a word, I have taken them from the subject itself, or as near to it as I possibly could.

I have not been willing to form any imagination concerning what kinds of inhabitants exist in those other worlds of which I write, because it was intirely impossible, and would have been only chimerical. I have endeavoured to say all that we may reasonably think; and even the visions which I have added hereto, have some foundation in reality. The true and the false are here blended together; but so, as they are always very easy to be distinguished. I attempt not to justify a composition so strange and fantastical; that, indeed, should be the most important article of the work;

work; and yet it is the only one for which I cannot give a proper reason.

There only remains one thing to be mentioned in this preface, which is, to excuse myself to a sort of persons who are perhaps very difficult to satisfy, not but that excellent reasons might be given them; but as they have the privilege of not submitting to very good ones, if they please, consequently the best will not content them. These are those scrupulous people, who may imagine that religion is in some danger, by placing inhabitants elsewhere than on the earth. I respect even their excessive delicacy on the subject of religion; and that respect I carry so far, as not willingly to shock it on this article in the following work, if it was even contrary to my private sentiments; but that which will appear more surprising is, I speak not only of inhabitants in this system, *i. e.* the system of our universe, or collection of planetary bodies: but, I have mentioned an infinite number of other worlds that are inhabited. It may be esteemed at most but as a little wandering of the imagination. When we say, that the moon is inhabited, we immediately form to ourselves the image of men made like us; and then, if you are ever so little of a divine, you find in the idea infinite difficulties. The posterity of ADAM have never extended themselves so far as the moon, nor have we ever sent colonies into that country; consequently the inhabitants who dwell in the moon are not the children of ADAM. Now, in theology, it is an embarrassing point, that

that there should be men any where who have not descended from him. There is not any occasion to say more, every imaginable difficulty is reduced to this point, nor would it be consistent to proceed, as the terms that we must employ in a longer explication, are too worthy of respect to be used in a work wherein there is so little serious as in this. The objection turns therefore wholly on the men in the moon; but it is those who make those objections that put men in the moon; for my part, I have not placed any there. I have mentioned inhabitants in the moon, but they are not said to be men like us. I have not seen them, nor have I spoke of them as if I had seen them; nor ought this to be looked upon as a finesse, which I have made use of for eluding the objection, to say that there are not men in the moon, you will see that it is impossible there should be such people formed as we are, according to the idea that I have of the infinite diversity which appears in all the works of nature. This assertion runs through the whole book, nor can it be contradicted by any philosopher; so that, I believe, it will be easily understood, that I have made this objection only to those who may speak of these discourses without having read them. But is this sufficient to insure me success? No, it is, on the contrary, to be feared, that many more objections may be made to several other parts of the work.

[The following is the purport of what the author says of this new edition.]

The

The reader will find, in this new edition, a great many additions interspersed throughout the whole book; the distances, magnitudes, and revolutions of the celestial bodies are herein expressed more precisely than in the former editions, and according to the calculations of our most eminent astronomers; and, in general, all the phænomena of the heavens, conformable to the most exact observations †. I will assure the readers, that upon all these points, as much dependance may be placed on this book, such as it is now presented to them, as if it was more learned and more profound. To this work the reader may add that new treatise on the Plurality of Worlds, composed by Mr. HUYGENS, a celebrated mathematician, which will afford very great pleasure to those who read it.

† All these particulars the reader will find again corrected in the notes, where the newest observations and discoveries, relative to these matters, are set down.





Milton's H Y M N

TO THE

C R E A T O R.

THESE are thy glorious works, Parent of good,
 Almighty, thine this universal frame,
 Thus wondrous fair; thyself how wondrous then?
 Unspeakable, who sit'st above these Heavens
 To us invisible, or dimly seen
 In these thy lowest works; yet these declare
 Thy goodness beyond thought, and pow'r divine.
 Speak ye who best can tell, ye sons of light,
 Angels; for ye behold him, and with songs
 And choral symphonies, day without night,
 Circle his throne rejoicing; ye in Heaven,
 On earth join all ye Creatures to extol
 Him first, him last, him midst, and without end.
 Fairest of stars, last in the train of night,
 If better thou belong not to the dawn,
 Sure pledge of day, that crown'st the smiling morn
 With thy bright circlet, praise him in thy sphere,
 While day arises, that sweet hour of prime.
 Thou Sun, of this great world both eye and soul,
 Acknowledge him thy greater, sound his praise
 In thy eternal course, both when thou climb'st;
 And when high noon hast gain'd, and when thou fall'st.
 Moon,

Moon, that now meet'st the orient sun, now fly'st,
 With the fix'd stars, fix'd in their orb that flies,
 And ye five other wand'ring fires that move
 In mystic dance, not without song, resound
 His praise, who out of darkness call'd up light.
 Air, and ye Elements, the eldest birth
 Of Nature's womb, that in quaternion run
 Perpetual circle, multiform; and mix
 And nourish all things; let your ceaseless change
 Vary to our great Maker still new praise.
 Ye Mists and Exhalations that now rise
 From hill or steaming lake, dusky or gray,
 Till the sun paint your fleecy skirts with gold,
 In honour to the world's great Author rise,
 Whether to deck with clouds the uncolor'd sky,
 Or wet the thirsty earth with falling showers,
 Rising or falling still advance his praise.
 His praise ye Winds, that from four quarters blow,
 Breathe soft or loud; and wave your tops, ye Pines,
 With every plant, in sign of worship wave.
 Fountains and ye, that warble, as ye flow,
 Melodious murmurs, warbling tune his praise.
 Join voices all ye living souls; ye Birds,
 That singing up to Heaven gate ascend,
 Bear on your wings and in your notes his praise.
 Ye that in waters glide, and ye that walk
 The earth, and stately tread, or lowly creep;
 Witness if I be silent, morn or even,
 To hill, or valley, fountain, or fresh shade
 Made vocal by my song, and taught his praise.
 Hail universal Lord, be bounteous still
 To give us only good; and if the night
 Have gather'd ought of evil or conceal'd,
 Disperse it, as now light dispels the dark.

Paradise Lost, Lib. V.

A YOUNG LADY,
WITH
FONTENELLE'S PLURALITY OF WORLDS.

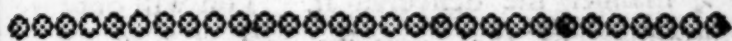
IN this small work, all nature's wonders see,
The soften'd features of philosophy.
In truth, by easy steps, you here advance,
Truth as diverting, as the best romance.
Long had these arts to sages been confin'd,
None saw their beauty, 'till by poring blind;
By studying spent, like men that cram too full,
From wisdom's feast they rose, not chear'd, but dull
The gay and airy smild to see them grave,
And fled from wisdom, like Trophonius' cave:
Justly they thought they might those arts despise,
Which made men sullen, ere they could be wise.
Brought down to fight, with ease you view them here;
Tho' deep the bottom, yet the stream is clear.
Your flutt'ring sex, still, valued science less;
Careless of any but the arts of dress.
Their useless time was idly thrown away
On empty novels, or some new-born play.
The best, perhaps, a few loose hours might spare
For some unmeaning thing, miscall'd a pray'r.
In vain the glittering orbs, each starry night,
With mingled blazes shed a flood of light:
Each nymph, with cold indiff'rence, saw them rise;
And, taught by fops, to them preferr'd her eyes.

None

None taught the stars were suns so widely sown,
 None dream'd of other worlds, besides our own
 Well might they boast their charms, when ev'ry fair
 Thought this world all, and her's the brightest here.
 Quit not the lofty thoughts this book inspires
 For those vain trifles which your sex admires ;
 Assert your claim to sense, and shew mankind,
 That reason is not to themselves confin'd.
 The haughty Belle, whose beauty's awful shrine
 'Twere sacrilege t' imagine not divine,
 Who thought so greatly of her eyes before,
 Bid her read this, and then be vain no more.
 How poor ev'n you, who reign without controul,
 If we except the beauties of your soul !
 Should all beholders feel the same surprize ;
 Should all who see you, see you with my eyes ;
 Were no sick blasts to make that beauty less ;
 Should you be what I think, what all confess ;
 'Tis but a narrow space those charms engage ;
 One island only, and not half an age !



INTRODUCTION.



TO MONSIEUR L***.

YOU are desirous, Sir, that I should give you a particular account of the manner in which I spent my time in the country with madam the marchioness of G***: But, do you know that this relation will make a volume, and, what is worse, that it will be a volume of philosophy? You expect to hear of feasts, parties of play, or of hunting, &c. when, on the contrary, you will only be entertained with conversations on the planets, and on other worlds, &c. there is scarce any thing else mentioned. Happily, you are a philosopher, and will not ridicule me so much as some others. Perhaps, you may even be pleased that I have drawn the marchioness into our philosophical party. We cannot make a more considerable acquisition; for, I think, that beauty and youth are far more valuable to us than any thing else. Don't you think, that if wisdom came to present herself to mankind with success, she would do right to appear under a form nearly resembling that of the marchioness? Above all, if her conversation was to be, in every respect, so very agreeable, I am persuaded

suaded that the whole world would follow wisdom. You are not, however, to expect wonders, when I relate to you the conversations that I have had with this lady; one must have as much wit as she hath to repeat all she hath said, and in the manner she delivered it. You will only see something of that vivacity and understanding, which, you know, she possesses. For me, I esteem her learned, because of the extreme facility with which she comprehended every thing. She wants nothing but to have read proper books; this is scarce any thing: for there are many people who have read all their lives, to whom I would refuse, if I durst, the name of learned. As to the rest, you will be under an obligation to me for communicating it. I know, before I enter into a detail of those conversations I have had with the marchioness, I should do right in describing to you the seat where she retired to pass the autumn. Descriptions of palaces, &c. have been given on less occasions; but I will save both you and myself that trouble. It is sufficient to inform you, that when I arrived in the country, I did not find any company with her; an agreeable circumstance which did not dissatisfy me. The two first days not any thing remarkable happened; they were passed in exhausting the news of Paris, from whence I came: but, in the end, the discourses that I am going to relate, employed a part of our time. I shall divide them into evenings; because that, in fact, we had these conversations only in the evening.



CONVERSATIONS

ON THE

PLURALITY of WORLDS.

THE FIRST EVENING.

*That the earth is a planet, which turns on itself,
and round the sun.*

ONE evening, after supper, we went to
take a turn in the park; the air, from
the heat of the preceding day, which
greatly fatigued us, was extremely refreshing; the
(1) moon had been risen, perhaps, about an hour,
B and

(1) The moon had been risen, perhaps, about an hour.]

Fontenelle introduces his conversations with a beautiful description of the night, somewhat resembling that by Homer, which, Mr. Pope says, exhibits, in the original, the finest night-piece in poetry; and as it cannot suffer any great disadvantage from the pen of that admirable translator, we shall here transcribe it.

As when the moon, refulgent lamp of night!
O'er heav'n's clear azure spreads her sacred light;
When not a breath disturbs the deep serene,
And not a cloud o'ercasts the solemn scene;

Around

2 CONVERSATIONS on the

and her lustre, which darted between the branches of the trees, made a most agreeable mixture of light and shade; the stars were arrayed in all their glory; they appeared like pure and shining gold, which was yet relieved by the blue arch in which they were set; and not a cloud appeared throughout the hemisphere to obscure the least of them. I was musing on this awful prospect, and lost myself in a kind of reverie; and, had it not been for the marchioness, I might not have awaked from it for a long time; but who can long contemplate on the moon or stars in the company of a charming woman? I am much mistaken if that be a proper time for contemplation. Well, madam, says I, to the marchioness, is not the night rather more pleasant than the day? The day, replied she, like a fair beauty, is clear and dazzling; but the night, like a brown one, is more soft and moving. You are very generous, madam, answered I, to give this preference to the brunetts, you who have all the charms that belong to the fair: but, is there any thing more beautiful in nature than the day? the heroines of romances, which are the produce of the finest imaginations, are made generally fair. Tell

Around her throne the vivid planets roll,
And stars unnumber'd gild the glowing pole,
O'er the dark trees a yellower verdure shed,
And tip with silver ev'ry mountain's head;
Then shine the vales, the rocks in prospects rise,
A flood of glory bursts from all the skies:
The conscious swains, rejoicing in the sight,
Eye the blue vault, and bless the useful light.

PLURALITY of WORLDS. 3

Tell me not, says she, of perfect beauty; nothing can be so that is not affecting. Acknowledge, that the fairest day hath never thrown you into so pleasing a resverie, as that into which I saw you ready to fall but a moment since. I agree, answered I; but a fair one, like you, can cast me into a resverie, sooner than the finest night in the world, with all its embrowned elegance. This is an affair I shall not now contend about, replied she; I would have the day (because the fair ought to be in its interests) have the same effect. But since you talk of romances, why do lovers, in their songs and elegies, address themselves to the night? It is the night, madam, replied I, that crowns their joys, and therefore deserves their applause. But it is to the night, answered she, they make all their complaints; and how comes it to pass, the day is so little trusted with their secrets? I confess, madam, says I, I can hardly account for it; methinks the night has somewhat a more melancholy air than the day, and fills them with plaintiff and gloomy complaints: they fancy the stars revolve more silently than the sun; and their thoughts then wander with more liberty, whilst they think all the world at rest but themselves: besides, the day is more uniform; we see nothing but the sun, and one blue vault in the firmament; whilst the night shews us a variety of objects, and hangs out ten thousand stars, disposed into a multitude of figures, which inspire us with as many pleasing ideas. She replied, what you say is true, I love the stars; there is somewhat charming in them; I could almost be angry with

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the sun for effacing them. And I cannot, says I, pardon him for keeping (2) all those WORLDS from my sight. What WORLDS, says she, looking earnestly upon me, do you mean?

I beg your pardon, madam, replied I; you have caused me to be guilty of folly, and I begin to rave. What folly, answered she; I discover none? Alas, says I, I am quite ashamed, if you should oblige me to confess it: I have long had a strong fancy that every star may probably be a sun, to enlighten other worlds: I will not, however, swear that it is true, but must think so, because it is so pleasant a fancy

(2) *All those WORLDS from my sight.*] The term World is commonly used to signify this earth, or terrestrial globe; or, according to our author, any planet resembling it, which receives light and heat from a sun. Here it may be necessary to observe, That though Fontenelle professes the system of Descartes, yet, contrary to the Cartesians, he maintains the doctrine of a plurality of worlds, the negative of which was supported by them, upon these principles: That it is a contradiction to say there are several worlds existing at the same time, since this implies several universes of created beings, the world being the *to war*. That if there were several worlds, they must be either at a distance from each other, or contiguous; but neither can be said; for, were they contiguous, they would only constitute one; and were they distant, there must be something between. But, say the Cartesians, what can be between? If it be extended, it is corporeal; and, instead of separating the several worlds, will connect them into one. But this is confounding the term world with the term universe, which is a collective name, signifying the assemblage of heaven and earth, with all things therein; and which the Cartesians, and other philosophers, imagine to be infinite.

Besides

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a fancy to believe it : it is an idea come into my head, which is very entertaining. If your folly be so very diverting, says the marchioness, pray make me sensible of it : provided I find a pleasure in it, I will believe as much of the stars as you would have me. I fear, madam, replied I, it is an entertainment you will not relish ; it is not like seeing a representation of one of Moliere's plays ; this is a pleasure rather of the fancy than of the judgment. I hope, answered she, you do not think me incapable of it ; teach me your doctrine of the stars, I will convince you of the contrary. No, no, says I, it shall never be said, by way of reproach to me, that I was talking philosophy in a wood, at ten o'clock at night, to the most amiable creature in the universe. You must search for your philosophers somewhere else.

I had resolution enough to defend myself for some time, in that manner ; but vain were my excuses ; who could resist such charms ? I was forced to yield. I made her promise, for my honour, that she would keep the secret ; and

B 3

yet,

Besides our author, the celebrated Mr. Huygens, in his *Cosmotheoros*, has endeavoured to prove a plurality of worlds : that is, that all the planets are habitable globes, like our earth ; and that the fixed stars are suns, which serve (in the same manner as our sun) to warm and enlighten other globes, or planets, revolving round them. This, indeed, affords a very magnificent idea of the immensity of the universe, and of the wisdom and power of its omnipotent creator ; and is called the *New System of the Universe*. However, by the word *System*, a number of planetary bodies is only meant, which move about one common centre or point ; and such a system is also sometimes called a world.

6 CONVERSATIONS on the

yet, when every objection was removed, I knew not where to begin; for to a person who understands not any thing of natural philosophy, one must go a great way about to prove, that the earth may be a planet; that the planets may be so many earths; and all the stars so many suns, which enlighten other worlds. However, to give her a general notion of philosophy, at last I resolved on this method.

Madam, says I, all philosophy is founded upon these two propositions, 1. 'That our minds are 'curious;' and, 2. 'That our eyes are bad;' for if our eyes were better than they are, we could not discover whether the stars were suns that enlighten other worlds, or not; and if, on the other hand, we were less curious, we should not care whether it were so or otherwise; which, I think, is much to the same purpose. But the difficulty is, we have a mind to know more than we can see: and again, if we could discern thoroughly well what things we do see, they would become too familiar to us; but we see things quite otherwise than they are. So that your true philosophers will not believe what they do see, and are always conjecturing at what they do not; which, I think, is a life not much to be envied: upon this occasion I fancy to myself, that nature very much resembles an opera; where you stand, you do not see the theatre as it really is formed, but as it is placed with advantage, and all the wheels and movements are hid, to make the representation, at a distance, the more agreeable: nor do you trouble yourself how, or by what means the machines

PLURALITY of WORLDS. 7

machines are moved, though certainly a machinist, hid in the pit, is affected with what does not touch you: he is pleased with a flying motion, and is demonstrating to himself on what it depends, and how it was performed. This engineer is like a philosopher, though the difficulty is greater on the philosopher's part, the machines of the theatre being not near so curious as those of nature, who disposes her wheels and springs so much out of sight, that we have been a long while guessing at what causes the motions of the universe. Let us imagine all the ancient sages to be at an opera, the Pythagoreans, Platonists, Aristotelians, and all the wise men who have made such a noise in the world, for these many ages: we will suppose them at the representation of the flight of Phaeton, where they see the aspiring youth lifted up by the winds, but do not discover the cords by which he mounts, nor know they any thing of what is done behind the scenes. One tells you, Phaeton is drawn up (3) by an hidden secret virtue, no matter where it lies: another says, Phaeton

B 4

is

(3) *By an hidden secret virtue, no matter where it lies.]*

Our author here seems to attack the Newtonian doctrine of attraction, as well as the magnetism or sympathy of Aristotle; and, indeed, the generality of foreign philosophers declare against this principle, for no other reason, than because they cannot conceive how a body should act on another at a distance. Philosophy, it is certain, allows of no action, but what is by immediate contact and impulsion; for how can a body exert any active power, where it does not exist? yet we see effects, without seeing any such impulse; and where there are effects, we

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(4) is composed of certain numbers that make him mount : (5) a third tells you, Phaeton has a secret love

we can easily infer there are causes, whether we see them or not. But a philosopher may consider such effects without entering into the consideration of the causes; for to exclude a number of phenomena, which we do see, will be to leave a great chasm in the history of nature; and to argue about actions, which we do not see, will be to build castles in the air. It follows, therefore, that the phenomena of attraction, are matter of physical consideration, and, as such, are intitled to a share in a system of physics; but that the causes thereof will become so, only when they appear to be the effects of some higher causes; for a cause is no otherwise seen than as itself is an effect; so that the first cause must, from the nature of things, be invisible. We are, therefore, at liberty, to suppose the causes of attraction what we please, without any injury to the effects. Sir Isaac Newton himself seems a little irresolute as to the cause; inclining, sometimes, to attribute gravity to the action of an immaterial cause, *Optics*, p. 343, &c. and, sometimes, to that of a material one, *ib.* p. 325.

In his philosophy, the research into causes is the last thing; and never comes in turn, till the laws and phenomena of the effect be settled; it being to them that the cause is to be accommodated. The cause of the grossest and most sensible action is scarcely known, *e. g.* how motion is communicated from body to body confounds the deepest philosophers. They say, it is by impulse or percussion, which terms are not only universally received into philosophy, but into mathematics; yet they are but mere terms; and the causes which produce these effects are as little known as those of attraction, which term the followers of Descartes so much cavil at.

(4) *Is compos'd of certain numbers that make him mount.*] This alludes to the Pythagorean System, that the planets were retained in their spheres by the power of the harmony of numbers.

(5) *A third tells you, Phaeton has a secret love for the*
top

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love for the top of the theatre, and cannot be at rest elsewhere: a fourth, that Phaeton was not formed for flying, but that he would rather fly, (6) than permit the top of the theatre to be void; with an hundred such extravagant fancies, that a man must wonder why these old sages should so long preserve their reputation: but now comes Descartes, with some of the moderns, and they tell you Phaeton ascends, because he is drawn up by cords, and that a greater weight than he descends; so that now we do not believe a body can move, unless it is pushed and drawn by another body, and that nothing can rise or fall but by the means of a counterpoise; to see nature then, as she really is, one must stand behind the scenes at the opera. I perceive, says the lady, philosophy is now become very mechanical. Yes, madam, replied I, so mechanical, that I fear we shall quickly be ashamed of it; they will have the world to be in large, what a watch is in little, that it is very regular, and depends only upon the

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just

top of the theatre.] Our author here alludes to the doctrine of sympathy, by which, and its contrary, hidden cause, called antipathy, the followers of Aristotle endeavoured to account for many of the phenomena of nature.

(6) *Than permit the top of the theatre to be void.*] Nature's abhorrence of a vacuum, that is, of a space where there is no kind of matter or body, was another reason given by the Peripatetics for explaining several effects, such as the rising of water in pumps, the swelling of flesh in a cupping-glass, &c. which are now universally ascribed to the pressure of the atmosphere.

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just disposition of the several parts of the movement. But, pray tell me, madam, had you not formerly a more sublime idea of the universe? Do not you think, that you honoured it then more than it deserved? for most people have the less esteem for it, after they have been acquainted with it. I am not of their opinion, says she: I value it the more, since I know it resembles a watch; and the more plain and easy the whole order of nature seems, to me it appears to be the more admirable.

I do not know, answered I, who has inspired you with such solid notions, but I am certain there are few who have them besides yourself: people generally admire what they do not comprehend; they have a veneration for obscurity, and look upon nature as a kind of magic, while they do not understand her, and despise her when once they are acquainted with her: but I find you, madam, so well disposed to enter with spirit into my argument, that I have nothing to do but to draw up the curtain, and shew you the world.

That noble expanse which appears farthest from the earth, where we reside, is called the heavens; that azure firmament, where the stars are fastened like so many golden studs, and are called fixed, because they seem to have no other motion than that of their heaven, which carries them with itself from east to west. Between the earth and this great vault, as I may call it, hang, at different heights, the sun and the moon, with the other five stars, which are called planets, Mercury,

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cury, Venus, Mars, Jupiter and Saturn. These planets, not being fixed in one and the same heaven, and having very unequal motions, have divers aspects and positions, with respect to each other: whereas, the fixed stars, in respect to one another, are always in the same situation: for example, (7) the chariot, which, you see, is composed of these seven stars, has been, and ever will be, as it now is; but the moon is sometimes nearer to the sun, and sometimes farther from it; and the rest of the planets move in like manner. Thus things appeared to the old Chaldæan shepherds, whose great leisure produced the first observations, which have since been the foundation of astronomy; which science had its birth in Chaldæa, as geometry sprung from Egypt, where the inundation of the Nile confounding the bounds of the fields, occasioned their inventing more exact measures, to distinguish every one's land from that of his neighbour. So that astronomy was the daughter of idleness, geometry the daughter of interest; and if we did but examine poetry, we should certainly find her to be the daughter of love.

I am

(7) *The chariot which you see.*] That is, the seven stars of the Great Bear, which revolve round the North Pole, every twenty-four hours, called also, by us, the Plough, or Charles's Wain; and, by the French, *le Chariot*. These stars have always had the same situation, in respect to each other, though the moon is sometimes nearer to the sun, and sometimes further from it, as in the text.

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I am glad, says the lady, I have learned this genealogy of the sciences, and am convinced I must stick to astronomy; my soul is not mercenary enough for geometry, nor is it tender enough for poetry; but I have as much time to spare as astronomy requires; besides, we are now in the country, and lead a kind of pastoral life, all which suits best with astronomy. Do not deceive yourself, madam, replied I, it is not a true shepherd's life to talk of the fixed stars and planets: they do not pass their time so in Astræa. That sort of shepherd's-craft, answered she, is too dangerous for me to learn: I love the honest Chaldeans, and you must teach me their rules, if you would have me improve in their science. But let us proceed: when they had placed the heavens in the disposition you tell me, pray, what is the next point in question? The next, says I, is the disposing the several parts of the universe, which the learned call making a system; but before I expound the first system, I would have you observe, we are all naturally like the Athenian idiot, who fancied all the ships that came into the Piræus, belonged to him: nor is our folly less extravagant, we believe all things in nature are also designed for our use; and do but ask a philosopher, to what purpose was that prodigious company of fixed stars created, when a far less number would perform the service they do us? He answers coldly, they were made to please our sight. Upon this principle they imagined the earth rested in the centre of the universe, while
all

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all the celestial bodies (which were made for it) took the pains to turn round to give light to it. They placed the Moon above the Earth, Mercury above the Moon, next Venus, then the Sun, after him Mars, then Jupiter, and lastly Saturn; above all these they set the Heaven of fixed Stars: The earth was placed just in the middle of those circles which the planets describe, and the greater the circles were, they were the farther distant from the Earth, and by consequence the farthest planets took up the most time in finishing their course; which, in effect, is true. But why, says the marchioness (interrupting me) do you seem to dislike this system: it appears to me very clear and intelligible. However, replied I, madam, I have made it plainer to you than it really is; for should I give it to you as it came from Ptolemy its author, or some others who have since studied it, I should frighten you, I fancy, instead of diverting you. Since the motions of the planets are not so regular, but that sometimes they appear to go faster, sometimes slower, sometimes are nearer the Earth, and sometimes farther from it; the ancients invented, I do not know how many orbs or circles, involved one within another, which they thought would solve all objections. This confusion of circles was so great, that at the time when they knew no better, a certain King of Castile, a great mathematician, (but not much troubled with religion) said, that, 'had God consulted him when he made the world, he would have told him how to have
' framed.

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'framed it better.' This saying favoured too much of the libertine, but, at the same time, it was pleasant enough; for this system was then the occasion of sin, because it was very confused: and, no doubt, the instructions he would have given the Almighty, were the suppressing those circles with which he had clogged the celestial motions, and the taking away two or three superfluous heavens, which were placed above the fixed stars; for these philosophers, to explain the motion of the celestial bodies, formed, beyond the last heaven that we see, an heaven of crystal, which impressed this motion on the inferior heavens; and where-ever they heard of another motion, they presently clapped up a crystal heaven, which cost them nothing. But why, says the lady, must their heaven be of crystal, would nothing else serve as well? No, no, replied I, nothing so well; for the light is to come through them, and yet they are to be solid. Aristotle would have it so; he had found solidity to be one of their excellencies, and when he had once said it, no body would be so rude as to question him. (8) But it seems there were comets which appeared much higher than the old philosophers ever had expected, which broke these crystal heavens by passing through them, and confounded the universe. This obliged them

(8) *But it seems there were comets that broke the crystal Heavens.*] The comets have not only contributed to overturn the Ptolemaic system, which our author has very exactly described, but also that of his favourite philosopher

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them to make the heavens fluid ; and by the observations of these latter ages, it is now out of doubt, that Venus and Mercury turn round the sun, and not round the earth, according to the ancient system which is every where exploded. But that system which I am going to lay down, will be quite satisfactory, and very simple, and is so clear, that the king of Castile himself may spare his advice. Methinks, answered the marchioness, your philosophy is like work proposed to undertakers, and he that offers to do it cheapest, carries it from all the rest. This, says I, is very true, nature is a great housewife, she always makes use of what costs least, let the difference be ever so inconsiderable ; and yet this frugality is accompanied with an extraordinary magnificence, which shines through all her works ; that is, she is magnificent in the design, but frugal in the execution ; and what can be more praise-

philosopher Descartes, who maintained, that the planets moved round the sun in vortices or whirlpools of matter moving in circles the same way : for as the number of comets is very considerable, and their motions perfectly regular, observing the same laws as the planets, and moving in conical orbits that are exceedingly eccentric ; and as they move every way, in all directions, and to all parts of the heavens, pervading and passing through the planetary regions, and going frequently contrary to them, which would be impossible, were there such vortices as those of Descartes ; these whirlpools would carry them along with them in their course, and prevent their passing towards the Sun, and their return from it, which it is well known they freely do. The Cartesian doctrine of vortices is further expatiated upon in a subsequent note.

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praise-worthy, than a great design accomplished with a little expence. But in our ideas we turn things topsy-turvey, we place our thrift in the design, and are at ten times more charge in workmanship than it requires; which is very ridiculous. I shall be very well pleased if the system you are going to speak of shall clearly imitate nature in her frugality; replied she; it will then give me little trouble to comprehend you. Madam, says I, fear it not, we have done with our useless embarrassments. Imagine to yourself the idea of a German, called Copernicus, confounding every thing, tearing in pieces the beloved circles of antiquity, and shattering their crystal heavens like so many glass windows; seized with the noble enthusiasm of astronomy, he took up the earth from the centre of the universe, sends her far from thence, and places the sun in the centre, to whom this honour did more justly belong; (9) the planets no longer turn round the Earth as their centre, nor is she inclosed in it by the

(9) *The planets no longer turn round the earth.* The planets are celestial bodies, that revolve round the Sun as a centre, and are continually changing their position, with respect to the other stars. They are distinguished into primary, and secondary. The first move round the Sun as their proper centre in the following order. Next to the Sun is Mercury, who revolves round him in 87 days, 23 hours. Venus is next, and performs her revolution in 224 days, 17 hours. The third planet in order from the Sun is our earthly globe, whose periodical revolution is performed in 365 days, 5 hours, 51 minutes. Without the Earth is Mars, who goes round the

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the circles they describe; if they give us light, it is but by chance, and as they meet us in their way:

the Sun in 686 days, 23 hours. Jupiter, the largest of all the planets, revolves round the Sun in 4332 days, 12 hours. Lastly Saturn, who is the most distant planet from the Sun, performs his revolution in 10759 days, 7 hours. This planet is encompassed with a ring, not visible, but with glasses. See plate I. fig. 4, 5, 6.

The secondary planets are such as move round some primary planet, as their respective centre, in the same manner as the primary do round the Sun; such are the Moon, moving round our Earth, which she does in 27 days, and 7 hours; besides 4 that move round Jupiter, and 5 round Saturn, which serve those planets also as moons. None of these secondary planets, belonging to Jupiter or Saturn, are visible without a telescope. The French astronomers have, according to the memoirs of their academy, lately discovered a moon, or secondary planet, attending also on Venus. Astronomers also call them Satellites. While they move round their respective primaries, they are also carried with them round the Sun. This disposition of the planets is called the Copernican system, which is represented plate I. fig. 1. They will be all severally treated of more particularly in the notes to the fourth evening's conversation.

The proportionable distances of the planets, together with the true proportion of their magnitudes, can never be shewn in any one machine, such as an Orrery or planetarium, much less upon paper; yet they may be represented by different machines and schemes; for if the body of the planet Saturn be represented in a planetarium or scheme of the size of a nutmeg, or $\frac{7}{8}$ of an inch in diameter, Jupiter will be about an inch in diameter; Mars the size of a common pin-head, or $\frac{6}{8}$ parts of an inch diameter; the Earth about the size of a larger pin-head, or $\frac{1}{8}$ of an inch diameter; Venus a little less; and Mercury smaller than the head of a minikin pin; and yet the Sun must be represented by a ball, or circle of more than 8 inches diameter, of the

way: all now turn round the sun, even the Earth herself; and Copernicus, to punish the Earth for her former laziness, makes her contribute all he can to the motion of the planets and heavens; and now stripped of all the heavenly equipage, with which

size of a large cannon ball. These proportions may be placed near each other; and shew how small a figure Jupiter, the largest of all the planets, makes to the Sun, *viz.* as a blue plumb to a large cannon ball of 8 inches diameter, and our earth is scarcely visible near it. The distances of the planets are not yet so exactly known as they will be after May 1761, when Venus will appear on the Sun's face, which will assist astronomers to determine the distance of the Sun and planets with great accuracy. However, supposing their magnitudes to be as above represented, no machine or scheme would shew their true distances: for in proportion to these magnitudes of a pin-head to represent the earth, and a cannon ball of more than eight inches diameter the sun, their distances in a machine must be 18 feet, and that of Saturn 800 from the sun; so that the orbit of Saturn would be more than a mile in circumference; and consequently no planetarium can ever be made to express the proportion of distances and magnitudes at the same time; and if it could be made so large, would be of little use, as we must walk from one part to another to view the several bodies; and Mercury, Venus, the Earth, and Mars, would be all of them by much too small to be seen from Saturn, without the help of a telescope; nor indeed could the three first be seen from Jupiter without one. If we suppose an Orrery of a mile circumference, to represent the proportionable distances of the planets, together with their magnitudes in our solar system, the Earth will be but almost a point or size of a pin-head in this circumference of a mile; consequently she bears no greater a proportion to the orbit of Saturn in the solar system, which again sinks into a point, when compared to the expanse and distance of the fixed stars.

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which she was so gloriously attended, she has nothing left her but the Moon, which still turns round about her. Fair and softly, says the marchioness, I fancy you yourself are seized with the noble fury of astronomy; which makes you explain things so pompously, that, I believe, I have not perfectly comprehended you. The Sun, you affirm, is in the centre of the universe, and is immoveable; what follows next? It is Mercury, says I; he turns round the Sun, so that the Sun is nearly in the centre of the circle wherein Mercury moves; above Mercury is Venus, who turns also round the Sun; after comes the Earth, which being placed higher than Mercury and Venus, makes a greater circle round the Sun than either of them; at last come Mars, Jupiter and Saturn, in the same order I name them; so that Saturn has the greatest circle round the Sun, which is the reason he is longer in making his revolution than any of the other planets. You have forgot the Moon, says the marchioness. We shall quickly find her again, replied I; the Moon turns round the Earth, and does not leave her, but as the Earth advances in the circle, which she describes about the Sun; the Moon follows her, always revolving round her, and if she turns round the Sun, it is because she will not quit the earth. I understand you, answered she, and I love the Moon for staying with us when all the other planets abandon us; nay, I fear, your German would have willingly taken her away too if he could; for in all his proceedings, I find he had no great regard
for

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for the Earth. It was well done of him, says I, to lessen the vanity of mankind, who had taken up the best place in the universe; and it pleases me to see the earth among the number of the planets. Sure, answered she, you do not think the vanity of mankind extends itself so far as to astronomy! Do you believe you have humbled me, in telling me the earth goes round the sun? For my part, I do not think myself the worse for it. I confess, madam, replied I, it is my belief, that a fair lady would be much more concerned for her place at a ball, than for her rank in the universe; and the precedency of two planets will not make half such a noise in the world, as that of two ambassadors; however, the same inclination which makes us desirous of the most honourable place at a ceremony, governs in a system; and if you love the uppermost place in the one, the philosopher desires the centre in the other; he flatters himself that all things were made for him, and he insensibly becomes interested in a matter of pure speculation. Freely confess that this is a calumny, says she, you have invented against mankind; why did they receive this system, if it was so humbling? I know not, answered I, but I am sure Copernicus himself distrusted the success of his opinion; it was a long time before he would venture to publish it; nor had he done it then, without the importunity of his friends. But do you know what became of him? The very day they brought him the first copy of his book, he died; he could not bear all the

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the objections he foresaw would be made to his opinion, and therefore very wisely slipped out of the way. We should do justice to all the world, says the lady, but it is hard to fancy we move, and yet find we do not change our place; we perceive ourselves in the morning where we lay down at night: perhaps you will tell me that the whole earth moves. Yes, certainly, adds I; it is the same thing as if you fell asleep in a boat upon the river, when you wake you find yourself in the same place, and the same situation, in respect to all the parts of the boat. It is true, replied she, but there is a great difference, when I wake I find another shore, and that shews me, my boat has changed its place. But it is not the same with the Earth, I find all things as I left them. No, no, madam, says I, the shore is also changed; you know that beyond the circles of the planets are the fixed stars, there is our shore, I am upon the Earth, and the Earth makes a great circle round the Sun; I look for the centre of the circle and see the Sun there; then I direct my sight beyond the sun in a right line, and should certainly discover the fixed stars which answer to the Sun, but that the light of the sun effaces them; but at night I easily perceive the stars that corresponded with him in the day, which is exactly the same thing: if the earth did not change place in her orbit or the circle where she is, I should see the Sun always against the same fixed stars; but when the Earth changes place, the Sun must
answer

answer to some other fixed stars, and there again is our shore, which is always changing. And seeing the Earth makes her circle in a year round the Sun, I see the sun likewise in the space of a year answer successively to a whole circle of the fixed stars, which circle is called the (10) Zodiac; I will

(10) *Called the Zodiac.*] The Zodiac is a broad circle, whose middle is called the ecliptic, in which the Sun seems to move, but in reality the earth. It is divided into twelve parts called signs, which were named from certain constellations (i. e. clusters of stars) through which this circle passes. These twelve are called Aries the ram, Taurus the bull, Gemini the twins, Cancer the crab, Leo the lion, Virgo the maid, Libra the ballance, Scorpio the scorpion, Sagittarius the Centaur, Capricornus the goat, Aquarius the water bearer, and Pisces the fishes. When the Sun seems to be in Aries, or in that part of the heavens occupied by the stars in that constellation, the Earth is then in Libra, which is exactly opposite to Aries; and when the Sun seems to be in Cancer, the Earth is in Capricorn, as will be perceived by Fig. 2. Plate I.

The names of these constellations were originally invented by the Egyptian priests, who marked the several months of the year, by the most remarkable incidents that happened in each. Thus, when the Sun entered Aries, which he does in March, the sheep bring forth their young; when he enters Taurus in April, the oxen do the same; antiently the constellation Gemini, or the twins, was represented by two kids (tho' afterwards by Castor and Pollux) which constellation the Sun enters in May, the time that goats bring forth. In June the Sun enters Cancer, or the crab; he then begins to descend, or, like the crab, to go backwards. His entering Leo, or the lion, in July, denotes the raging heat of summer. Virgo is represented on the sphere as a woman, with a wheaten ear in her hand, to denote an har-

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will draw you the figure of it, if you please, on the sand? It is no matter, replied the lady, I can do well enough without it: besides, it will give an air of learning to my park, which I would not have in it: for I have heard of a certain philosopher, who being shipwrecked upon an unknown island, seeing several mathematical figures traced on the sea-shore, cryed out to those who followed him, 'Courage, my companions, the isle is inhabited, behold the marks of men.' But you may spare your figures, such footsteps are not necessary here.

I confess, madam, added I, that, in fact, the footsteps of lovers, would better become this place; that is, I would have your name and cypher

harvest gatherer, which is performed in August. He enters Libra, or the ballance, in September, which points out the equality of day and night in that month. Scorpio, or the scorpion's sting, denotes the unhealthiness of October, an autumnal month, which was very sickly in Egypt. Sagittarius, or the Centaur (by which the Egyptians denoted a man on horseback) furnished with a bow and arrows, points out the hunting season, in November. Capricornus, or the mountain goat, into which sign the Sun entered in December, denotes his beginning to ascend or climb again up the heavens, which he ceased to do since he passed the sign Cancer in June. Aquarius in January, denotes the rainy month; and lastly Pisces, or the fishes, points out the time for fishing in February.

These signs are distinguished by the following characters,

Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, Pisces ♓.

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pher be carved on these trees, by the hands of your adorers. Tell me not, says she, of lovers and adorers, speak of the Sun. I understand very well the reason why we imagine, that the Sun describes a circle which we ourselves describe, and that this is completed in one year; but there is another that the Sun describes every day over our heads, how is that performed? Did you never, replied I, observe a bowl on the green to have two motions? It runs towards the jack, and, at the same time, turns very often round itself; so that the parts which were above are below, and those which were below are above: just so it is with the Earth, at the same time that she advances on (11) the circle, which, in a year's space, she makes round the Sun, every 24 hours she turns round herself; so that in 24 hours, nearly,
every

(11) *The circle, which, in a year's space, she makes round the Sun, every 24 hours she turns round herself.* The different inequalities of day and night throughout the year will be easily comprehended by Fig. 4. Plate IV. which represents an oblique sphere, in which the great circle P H R Q W D, is the meridian, on which the Sun's rays T Æ V shine every day at 12 of the clock. T R represents the tropic of capricorn, or circle the sun makes round the earth in June on the longest day in the year; that part of it from X to R, represents the twilight during that season. The æquator, or equinoctial circle, is represented by Æ Q, one half of which is above the horizon O H, and the other half is below the same, which represents equal day and night to all parts of the earth; this happens in March and September. V W represent the tropic of capricorn, or circle

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every part of the Earth loses the Sun, and recovers him again, and as it turns towards the Sun, he

C

seems

circle the sun makes round the earth, on the shortest day in December, V Z represents the shortness of the day, and Z W the length of the night at that season. O H A R represents the bounds of the twilight, and a b the course of the sun. P D the poles on which the earth turns. It is further evident by the following figure (Plate IV. Fig. 5.) that the annual motion of the earth round the ecliptic, will make the sun appear to us as if it had such a motion; and the variety of days and nights, and seasons of the year, may be also solved by the annual motion of the earth. Thus, let the circles A Q B E represent the earth. A B will be the extremities of the axis or poles on which it turns every 24 hours. B represents the north pole which points upwards, and A the south pole pointing downwards; between these poles, each point of the earth, by its daily revolution describes a circle, of which that which is in the very middle between the poles is the greatest, and is called the equinoctial or æquator, denoted by E Q, because when the sun shines perpendicularly on it, it is then equal day and night all over the earth; and did this circle answer to, or run along under the ecliptic, there would be equal day and night, throughout the year, all over the globe; but as the æquator crosses the ecliptic, hence it is equal day and night only twice in the year; namely, when the sun appears in the first degree of Aries, and of Libra in March and September. Besides the æquator, there are 4 other circles, *viz.* the two tropics, and the two polar ones. The first are the two circles the sun seems to describe when he is farthest from the æquator north or south. One of these is called the tropic of Cancer, because the sun appears to be then, in the beginning of Cancer; and for the same reason, the southern is stiled the tropic of Capricorn. These are marked T C M N. The two polar circles are as far distant from the poles, as the tropics from the equator, *viz.* 23 degrees and a half,

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seems to rise ; and in proportion as it turns from him, he seems to set. It is very pleasant, says she,

a half ; they are represented by R I F G. These polar circles bound the limits of day and night for 6 months of the year, each in its turn.

It only remains to observe, that the sun will appear vertical, or directly over that part of the earth, where a right line drawn from its centre to the centre of the earth cuts the earth's surface. Thus, when the earth is in the beginning of Capricorn or at ♄, the sun will appear to be vertical to the tropic of Cancer T C, because a right line drawn from the center of the sun, will cross the surface of the earth at P. So when the earth is in ♈, the sun will appear vertical to the terrestrial æquator E Q. These particulars being well understood, suppose then the earth to be at Libra ♎, the sun will appear at ♈ Aries, and so in one of the equinoctial points, and in the middle between the two poles A and B, and consequently, will enlighten from pole to pole that half of the earth which is opposite to it. Whence half of the terrestrial æquator E Q, and of every circle parallel thereto, will be enlightened by the sun, and half will be in the dark, consequently the days and nights will then be equal.

The earth being arrived from ♎ Libra to ♄ Capricorn, the sun will appear in ♋ Cancer. The solar rays now reach beyond the north pole to L, consequently all the north polar circle has then constant day, and at the south pole they reach only to F, whence the southern polar circle hath then constant night. It follows hence also, that all that part of the earth between the æquator and north polar circle, have longer days than those parts south of the æquator ; and it is consequently summer on the north side, and winter on the south side of the equator at that time. The earth moving from ♄ Capricorn to ♈ Aries, the sun will seem to move from ♋ Cancer to ♎ Libra, and so will appear in the æquator, and make day and night equal, as when the earth was at the opposite point ♎ Libra, for the above reasons.

she, that the Earth takes all upon herself, and the Sun does nothing; and when the Moon, the other planets, and the fixed stars seem to go over our heads every 24 hours, you will say, that too is only the effect of fancy. Mere fancy, madam, which proceeds from the same cause; for the planets only compleat their courses round the Sun at unequal times, according to their different distances; and that planet which to-day we see answer to a certain point in the Zodiac, or circle of fixed stars, to-morrow will answer at the same hour to another point, because it is advanced on its own circle, as well as we are advanced upon ours: we move, and the other planets move too, but with more or less rapidity than we do: this puts us in different points of sight in respect to them, and makes us think their courses are irregular; but there is no occasion for discoursing to you on that head; it is sufficient to inform you, that what seems irregular in the planets, proceeds only from

C 2

our

reasons. In like manner the earth moving from ♈ Aries to ♋ Cancer, the sun will seem to move from ♎ Libra to ♏ Capricorn, where it is in its greatest southern declination, and consequently, at this time of the year, the like phænomena will happen to the inhabitants on the south side of the equator, as happened to those on the north side, when the earth was in ♏ Capricorn; and the like phænomena will be in the north side of the æquator, as was before on the south side.

The reader is to observe that the axis of the earth, in every part of its orbit, is always parallel to itself. As A B, A B, A B, A B, in the four positions of the earth represented in fig. 5. and every other position whatsoever are always parallel.

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our motion, when, in truth, they are all very regular. I will suppose them so, says the lady, but I would not have their regularity put the earth to so great trouble; methinks they exact too much activity from so ponderous a mass. But, says I, had you rather that the sun and all the stars, which are vast great bodies, should in 24 hours make a prodigious tour round the earth; and that the fixed stars, which are in a circle of infinite extent, whose movement is always extreme, should run in a day, twenty-seven thousand six hundred and sixty times two hundred millions of leagues, as they needs must do, if the earth did not turn round itself every 24 hours? To say the truth, it is much more reasonable to think, that she should make the tour, which at most is not above nine thousand leagues; you perceive plainly, that to set nine thousand leagues, against the number I have just mentioned to you, is no trifling difference. Oh, says she, the sun and the stars are all composed of fire, their motion costs them nothing: but the earth, I fancy, is a little too unweildy to move. That, replied I, signifies nothing; for would you suppose that a first rate ship, if you had not known it, which carries 100 guns, and above 1000 men, besides great quantities of merchandize, could be moved by one puff of wind, which you see sets her a sailing, because the water is liquid, and being easily separated, it very little resists the motion of the ship; or if she sailed in the middle of a river, she would without difficulty drive with the

the stream, because there is nothing to oppose her course; so (12) the earth, tho' never so weighty, is as easily borne up by the celestial matter,

C 3

which

(12) *The earth is as easily borne up by the celestial matter.*] The Cartesians hold, that the matter of this world was, at its first formation, divided into innumerable little equal particles, each endowed with an equal degree of motion, both about its own centre, and separately so as to constitute a fluid.

Several systems, or collections of this matter, they further hold, to be endowed with a common motion about certain points, as common centres, placed at equal distances; and that the matters moving round these, composed so many vortices, or whirlpools of matter, in which the planets are carried about the sun. But not only the phænomena of comets has contributed to set aside this hypothetical system (as is mentioned in a foregoing note, page 14) but there are many other unanswerable objections against it. One is, that if it were granted that several vortices were contained in the same space, they must penetrate each other, particularly the vortex which carries the moon round the earth, must penetrate the vortex of the earth's annual orbit; and so of the other secondary planets, and consequently disturb the regularity of their motions; and it may be asked, how they should have been preserved entire so many ages, and not be disturbed and confounded by the adverse actions and shocks of so much matter as they must meet withal?

Besides, the planets are not carried round the sun in circles, but in ellipses (or long ovals) which have the sun in one of their foci: an oval is a very improper figure for a whirlpool or vortex to assume; nor can any vortex, as the illustrious Sir Isaac Newton has observed, [Schol. prop. ult. Lib. 2. princip.] carry the planets so as to describe areas proportionable to the times of their revolutions. Again, Dr. Keil has proved, in his examination of Burnet's theory, that if the earth were carried in a vortex, it would move faster, in the proportion of three to two,

which is a thousand times more fluid than the water, and fills all that great space where planets

two, when it is in Virgo, than when it is in Pisces; which all experience proves to be false.

But we have another principle which accounts for the same phenomena, much more satisfactorily than this of vortexes, and which has an actual existence in the nature of things; and this is gravity, or the weight of bodies, [see the note on attraction, p. 7.] which gives them a natural tendency or inclination towards their centre. To account for the motion of the planets round the sun, there needs nothing but to suppose, a uniform motion first impressed upon them, which would cause them to move in strait lines, and the power of gravitation, such as we observe in all the great bodies of our system. For a body, Plate I. fig. 3. proceeding uniformly along the line *A B*, will, by the intervention of the attracting body *C*, be every moment diverted from proceeding in a right line, and bent into a circular path. If then the projectile motion (i.e. it's first motion in a strait line) be perpendicular to a line *C A*, drawn from the attracting body *C*, and its velocity (quickness of its motion) be so proportioned to the force of attraction of *A*, as that both these powers are equal, or balance each other, the body will move in a circular orbit *A b c d e*. If the planet's motion in a right line *A B*, be not in proportion to the sun's attraction at *C*, the orbit described will be an ellipsis, or oval, not a circle; and the same would happen if the first direction *A B*, was oblique and not perpendicular to *C A*. The motions of the planets are not equable, that is, they do not run through the same quantity of space always in the same time. The cause of this is, the sun is not in their exact centre, but in one of their foci, which is that part of the ellipsis or oval, wherein the rays or right lines, drawn from all parts of such a course, do concur and meet. A point well known to mathematicians but not so readily to be described to persons unacquainted with conic sections, for whose sake these notes were drawn up.

Hence,

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planets float; for how would you have the earth fastened to resist the motion of the celestial matter, and not be driven away by it? You may as well fancy a little bowl of wood can withstand the current of a river. But pray, says she, how can the earth, with all its weight, be borne up by your celestial matter, which must be very light, because it is so fluid? It does not argue, answered I, that what is fluid, is light: for what think you of the great ship I mentioned just now, which, with all its burthen, is yet lighter than the water it floats on? I will have nothing to do with the great ship, says she, with some warmth; but assure me now, is there not any thing to apprehend, upon such a light whirligig as you have made of the earth. There is no danger, replied I; but, madam, if your fears increase, we will have the earth supported by four elephants, as the Indians believe it to be. Hey day, cried she, here is another system; however, I love those people for taking care of themselves, they have a good foundation to trust to, while, on the contrary, we Copernicans are a little too adventurous to swim on this celestial matter; and yet I fancy, if the Indians thought the earth in the least danger of moving, they would double their number of elephants.

This deserves praise, says I, laughing at her

C 4

fancy;

Hence, the planets move sometimes slower, sometimes faster, as they are nearer or further from the sun, but yet these irregularities are all certain, and succeed each other according to an immutable law of nature.

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fancy ; they would not spare elephants to sleep in safety ; and if you have occasion for them to night, we will put as many as you please in our system, we can take them away again by degrees, as you grow better confirmed in the opinion of your safety. I do not think them very necessary, replied she, I have courage enough to venture to turn. You shall yet go further and turn with pleasure, madam, says I, and you shall find delightful ideas in this system. For example, sometimes I fancy myself suspended in the air, without any motion, while the earth turns round me in 24 hours ; I see I know not how many different faces pass under me, with which the globe is peopled, some white, some black, and some tawny ; at first I see hats, then follow turbans ; now heads with hair, and then bald pates ; here I see cities with steeples, others with spires and crescents, some with towers of porcelane ; and again, great countries with nothing but huts ; here I see vast oceans, and there most horrible deserts ; in short, I discover the infinite variety which is upon the surface of the earth.

I confess, says she, 24 hours would thus be very well bestowed, so we were in the place where we are now, I do not mean in this park, but we will suppose ourselves suspended in the air immediately over it, other people continually passing by, who take up our place, and at the end of 24 hours we return to it again.

Copernicus himself, answered I, could not have comprehended it better : first then we might see

the

the English passing by us, who, perhaps, reason on politics with more gravity, than we reason on philosophy; then follows a great sea, and there we may see perhaps some vessel, not quite in that easy tranquillity as we are in at present; then come some of the Iroquois going to eat a prisoner of war for their breakfast, who seems as little concerned as his devourers. After appear the women of the land of Jesso, who spend all their time in dressing provisions for their husbands, and painting their lips and eye-brows blue, only to please the greatest brutes in the world. Then the Tartars going devoutly on pilgrimage to their grand priest, who never comes out of a gloomy apartment all hung with lamps, by the light of which they pay their adoration to him: then the fair Circassians, who make no scruple of granting every thing to the first comer, except what they think essentially belongs to their husbands: then the inhabitants of little Tartary, who are going to steal concubines for the Turks and Persians: and at last, come our own dear countrymen, in some points, probably, as ridiculous as the best of 'em.

This, says the marchioness, is very pleasant, to imagine what you tell me; yet tho' I were above, and saw all this, I would have the liberty to hasten or retard the motion of the earth, according as objects pleased me more or less; and I assure you, I should quickly send packing the politicians and man-eaters, but should have a great curiosity to retard the fair Circassians, who have

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a custom so very particular. But I have a difficulty to solve, and you must be serious. If the earth turns round, the air changes every moment, so we breathe the air of another country. Not at all, replied I; for (13) the air which encompasses the earth, does not extend above a certain height, perhaps

(13) *The air which encompasses the earth.*] Here Fontenelle means the whole mass, or assemblage of ambient air, which surrounds this globe that we inhabit. Among the more accurate writers that part of it which is next to the earth is called the atmosphere, which receives vapours and exhalations; and is terminated by the refraction of the sun's light. The further or higher spaces, though perhaps not altogether destitute of air, are supposed to be possessed with a finer substance called æther.

Philosophers have invented a great many instruments for measuring the alterations of the atmosphere, as its weight by the barometer, its moisture and dryness by the hygrometer, and its different degrees of heat and cold by the thermometer, of all which instruments there are various kinds.

To give an adequate account of the nature, constitution, properties, and uses of the air and atmosphere, would lead us far beyond the bounds of these notes, and even of this volume; we shall therefore refer the reader to Gravesande, Boyle, Boerhaave, Derham, and other writers on this subject.

Considering the immense quantity of all kinds of fuel and combustible matters, that are daily consumed and evaporate in the air; considering the numberless steams and clouds of smoke that continually overwhelm populous cities; the noisome exhalations that arise from thronged infirmaries, and loathsome gaols; from stagnating waters, putrid fens, and the vast perspiration of trees and vegetables; and the variety of offensive and unwholesome effluvia, that proceed from other causes;—it is a very remarkable instance of a providence, at once tenderly kind, and infinitely powerful, that mankind

perhaps 20 leagues; it follows us and turns with us: have you not seen the labours of the silk-worm, the shells which those little insects imprison themselves in, and weave with so much art and closeness; but yet their covering is of a down very loose and soft: so the earth which is solid enough, is covered from the surface 20 leagues upwards with a kind of down, which is the air, and like the shell of the silk-worm turns at the same time. Beyond the air is the celestial matter, incomparably more pure and subtle, and much more agitated than the air.

Your comparison, says she, is somewhat despicable, and yet what labours are wrought, what wars, what changes are effected in this little shell, whilst such an agitation reigns on all sides. It is true, replied I, but nature takes no notice of such minute particulars, but drives us along with the general motion, as if she were at bowls.

Methinks, says she, it is very ridiculous to be upon a thing that turns, and give ourselves perplexity, and yet we are not well assured that it does turn: and to tell you the truth, nothing appears to me to move; and from the many precautions

kind is not suffocated with stench; that the air is not choaked with filth. The air is, the common sewer, into which ten thousand times ten thousand nuisances are incessantly discharged; and yet is preserved so thoroughly clear, as to afford the most transparent medium for vision; so delicately undulatory, as to transmit, with all imaginable distinctness, every diversity of sound; so perfectly pure, as to be the constant refiner of fluids in every animal that breathes. *Hervey's contemplations on the night.*

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tions taken to prevent the perceiving this motion, I suspect it ; (14) why should we not be sensible of the motion of the earth ; for is it possible there should not be some little mark left, by which we might perceive it ?

All

(14) *Why should we not be sensible of the motion of the earth ?*] Our author has given very proper reasons why we are not sensible of this motion ; and as that of Galileo answers all, or most of, the objections made to it, we shall here give it to the reader. “ Shut,” saith he, “ yourself up with your friend in the great cabbin of a ship, together with a parcel of gnats and flies, and other little winged creatures. Procure also a great tub of water and put fishes therein. Hang also a bottle of water up, to empty itself drop by drop into another such bottle, placed underneath with a narrow neck. Whilst the ship lies still, diligently observe how these little creatures fly with the like swiftness towards every part of the cabbin ; how the fishes swim indifferently towards all sides ; and how the descending drops all fall into the bottle underneath. And if you throw any thing to your friend, you need use no more force one way than another, provided the distances be equal. And if you leap you will reach as far one way as the other. Put the ship in motion, so as to sail smoothly on, you shall not perceive any alteration in the aforesaid effects, neither can you conclude from them whether the ship moves or not : and if you burn incense, and make a little smoak, you will perceive that the cloud will move indifferently every way. The cause of which correspondence of the effects, is, that the ship’s motion is common to all things contained in it, and to the air also ; I mean when these things are shut up in the cabbin : but when they are above deck in the open air, and not obliged to follow the ship’s course, differences more or less may arise among the forenamed effects.” Thus Galileo has answered most of the objections

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All motions, replied I, the more common and natural they are, are the less perceptible; and this holds

objections made against the earth's motion. The chief of which are, That a ball shot westward, ought to have a farther range than one shot eastward, if the earth moved from W. to E. or if shot N. or S. it would miss the mark; or if perpendicularly upward, it would fall to the west of the gun: that a weight dropped from the top of a tower, would not fall perpendicularly to the bottom as it now does: that birds flying towards the E. would be hindered in their flight, but forwarded in flying westward, with much more to the same purpose. With what amazing speed this vessel our earth (if I may carry on Galileo's allusion) filled with a multitude of nations, and freighted with all her possessions, makes her way through the ætherial space? During the diurnal revolution, the earth whirls about at the rate of 1043 miles in an hour: for her diameter being 7967.7 miles, the circumference thereof is 25031.4 miles, which, divided into 24 hours, makes the revolution to be 1043 miles each hour. And as the great orbit, which it describes annually round the sun, is reckoned at 540 millions of miles, it must travel near a million and a half each day. What an amazing force must be requisite to protrude so vast a globe; and wheel it on at such a prodigious degree of rapidity! It surpasses human conception! How natural, how pertinent, after such an observation, is the acknowledgement made by holy Job, 'I know that thou can'st do every thing, and that no thought can be withholden from thee. Chap. xlii. 2.

Besides Galileo's experiment on ship-board, that in a common windmill may be added, to convince any body of the deception of vision. If the mill be turned round, to a person in the mill, an apparent motion will appear in the centre or swivel post on which the mill turns, whilst the mill will seem at rest; when in reality there is no motion in the post, but in the mill, which causes that surprizing appearance in the post. Consequently,
the

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holds true even in morality; the motion of self-love is so natural to us, that for the most part we are not sensible of it, and we believe we act by other principles, when it is only that which actuates us. Ah! says the marchioness, now are you moralizing, to a question of astronomy, which is running wide of the argument: but enough, this lecture is sufficient for the first time; let us now depart and meet here again to-morrow, you with your systems, and I with my ignorance.

In returning back to the castle, that I might say all I could on the subject, (15) I told her of a third system, invented by Tycho-Brahe, who insisted

on the earth may appear to be at rest, and yet really move; and the daily motion of the sun and other heavenly bodies, may not be real, but apparent.

(15) *I told her of a third system invented by Tycho-Brahe.* We have given a representation of this system Plate II. fig. 4. It takes its name from the author, and is called the Tychonic system. He was a nobleman of Denmark; and the greatest astronomer of the age he lived in. He had an observatory in an island called Veena, in the sound of the Baltic Sea, which was erected on the top of a castle, named Uranibourgh, and well furnished with instruments for observing the course and motions of the heavenly bodies. It was finished in 1580, and did not subsist above 17 years. Tycho being obliged to abandon his country, those to whom the island was given demolished the observatory; part of the ruins were dispersed into divers places, the rest served to build Tycho an handsome house on his antient estate, which still bears the name of Uranibourgh: it was at this last place he composed a catalogue of the fixed stars.

But to return to his system. He, with Ptolemy, places the earth immoveable in the centre, round which the

on the Earth's being immoveable; and had fixed her in the centre of the world, turned the sun round the earth, and the rest of the planets round the sun; for since the new discoveries, there was no way left to have the planets turn round the earth. But the lady, with the quickest apprehension, replied, she thought that too affected a system, that among so many great bodies, the earth only should be exempted from turning round the sun; that it was improper to make the sun turn round the earth, when all the planets turned round the sun; and that tho' this system was to prove the immobility of the earth, yet she thought it very improbable: so we resolved to stick to Copernicus, whose opinion we thought most uniform, probable, and diverting. In a word, the simplicity of his system convinces us, and the boldness of it surprizes with pleasure.

The

the sun and moon revolve in orbits, respecting the same as a centre; but the other five planets are supposed, with Copernicus, to revolve round the sun as their centre; so that the orbits of the three superior planets include the earth, but not those of the inferior ones, because they are nearer to the sun than the earth is.

Accordingly, he supposes the heavens to be fluid, and to consist of three different orbs or spheres; the first moveable, supposed to make a revolution in 24 hours; the second the sphere of the planets; and the third the sphere of the firmament, or region of the fixed stars.

The SECOND EVENING.

That the MOON is an Habitable World.

THE next morning, as soon as any one could get admittance, I sent to the marchioness's apartment, to know how she had rested, and whether the motion of the earth had not disturbed her? She returned for answer, that she began to be accustomed to it, and that Copernicus himself had not slept better. Soon after, there came a crowd of visitors to dinner, who staid with her till the evening, according to a tiresome custom that prevails in the country; and they were very obliging even in going then; for the country customs likewise give them a privilege of extending their visits to the next morning, if they are so disposed, and have not the complaisance to break up. The lady and myself, finding ourselves at liberty, in the evening, went again to the park, and immediately our discourse turned upon our systems: she had so well retained what I told her, the night before, that she disdained to speak again of it, and desired I would proceed, without any repetition to something new. Well, madam, says I, since the sun, which is now immoveable, has left off being a planet, and the earth which turns round him is now become one, you will not be surprized when you hear

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hear (1) that the moon is an earth too, and an habitable world. I confess, says she, I have often heard

(1) *That the moon is an earth.*] The different appearances of the moon are termed her phases; to conceive the cause of which; see Plate I. fig. 6. where S represents the sun; K L a part of the earth's orbit, or path round him; A B C D F G H I the orbit of the moon revolving round the earth E, in the space of a lunar month, advancing from east to west. Draw right lines from the centre of the sun, to that of the moon, as S A, S B, S C, S D, &c. which lines will represent the solar rays illuminating that side of the moon which is turned towards the sun. Draw other right lines from the centre of the earth E, to the verge of the moon's limb, as E A, E I, &c. these will shew that part of the moon which is turned towards the earth, in all her different situations, and the quantity of light she presents to a spectator on the earth. Thus, at A, all the enlightened side of the moon is turned towards the earth, in which case she is, in respect of us, at the full, and shines the whole night; and with respect to the sun, she is said to be in opposition, in regard the sun and moon are then seen in opposite parts of the heavens. When the moon appears at B, the whole illuminated face is not turned towards the earth; so that the visible illumination will then be less than a circle, and the moon is then called gibbous, or bunched out. When she reaches C, then only one half of the diminished face is turned towards the earth, and then we observe an half moon. In this situation, the sun and moon being but a fourth part of a circle from each other, the moon is said to be in her quadrature. Arriving at D, only a small part of her illuminated side is turned towards the earth, for which reason the small part that shines upon us will seem horned. At last, the moon arriving at F, shews no part of her illuminated face to the earth; this position is the new moon, and she is then said to be in conjunction with the sun. At this time solar eclipses always happen, when she is directly between the sun and earth, so as to obscure his light; but

heard talk of the world in the moon ; but I always looked upon it as visionary, and mere fancy. And, replied I, it may be so still ; I am in this case, as people in a civil war, where the uncertainty of what may happen, makes them hold intelligence with the opposite party, and correspond with their very enemies ; for though I believe the moon is inhabited, I live civilly with those who do not believe it ; and I am still ready to embrace the prevailing opinion ; but till the unbelievers have a more considerable advantage, I shall give you my reasons why I declare for the inhabitants of the moon.

Suppose there had never been any communication between Paris and St. Dennis, and one, who was never beyond the walls of this city, saw St. Dennis from the towers of Notre-Dame ; you ask him if he believes St. Dennis is inhabited as Paris is ? he presently answers boldly, no ; for, says he, I see very well the people at Paris, but those

but as she is generally higher or lower than the sun, at the time of new moon, solar eclipses rarely happen. As she advances towards G, she resumes her horns, and, as before in the new moon, the horns were turned westward, so now they look eastward. When she comes to H, she is again in her quadrature, and becomes an half moon ; in I, she becomes more round or gibbous ; and, lastly, in A full again ; where, if the earth and she be in a right line with the sun, a lunar eclipse happens, which must be at the time of full moon ; but as she is generally higher or lower than the earth's shadow at the time of being full, she commonly escapes being eclipsed thereby. Keil, in his lectures, p. 121, says, that the moon's least distance from the earth is 56 semidiameters of the earth.

those at St. Dennis I do not see at all, nor did I ever hear them speak: it is true, you tell him, that from the towers of Notre-Dame he cannot perceive any inhabitants of St. Dennis, because of the distance; but all that he does discover of St. Dennis, very much resembles what he sees at Paris, that St. Dennis has steeples, houses and walls, so that it may very well be inhabited as Paris is. All this signifies nothing, my Parisian still maintains that St. Dennis is not inhabited, because he sees no body there. The moon is our St. Dennis, and every one of us is like this Parisian citizen, who never went out of his own city.

You are too severe, says she, upon your fellow citizen; we are not all sure so silly; since St. Dennis is just like Paris, he is a fool if he does not think it inhabited: but the moon is not formed at all like the earth. Take care what you say, Madam, replied I, for if we prove that the moon resembles the earth, in every respect, you will be under a necessity to believe it inhabited. If it be so, says she, I own I cannot be dispensed from believing it; and you seem so confident of it, that I fear I must, whether I will or no. It is true, the two motions of the earth (which I could never imagine till now) do a little stagger me as to all the rest; but yet, how is it possible the earth should enlighten as the moon does, without which they cannot be alike? If that be all, added I, to be luminous, is not so great a thing as you imagine; for it is only the sun which is the sole fountain of light; that particular quality proceeds
only

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only from him ; and if the planets give light to us, it is because they first receive it from the sun ; the sun sends light to the moon, and she reflects it back on the earth ; (2) the earth, in the same manner, receives light from the sun, and sends it to the moon ;

(2) *The earth, in the same manner, receives light from the sun.*] As the moon illumines the earth by a light reflected from the sun, so is she reciprocally illumined by the earth ; which being 15 times larger, returns 15 times more light to the moon, than she receives from the earth. At new moon, the illumined side of the earth is turned fully towards the moon, and will then fully illumine the dark side of the moon ; and then the lunar inhabitants, if such there be, will have a full earth, as we, in a similar situation, have a full moon. And this is the cause of that dim light observed in the old and new moon ; whereby, besides her bright horns, we perceive more of her body behind them, but obscurely. In short, the earth will present all the same different phases to the moon, as she does to the earth.

If the moon was of herself a luminous body, she could never be eclipsed by the interposition of the earth, between her and the sun ; consequently all her light is borrowed from him.

Before we conclude this note, we must beg leave to add a few words from Mr. Hervey's contemplation on the night, relative to this luminary. " If," says he, " we choose to prolong our journey after the sun is gone down ; the moon, during her whole increase, is ready to act in the capacity of a guide. If we are inclined to set out very early in the morning ; the moon in her decrease, prevents the dawn, in order to offer her assistance. And, because it is so pleasing a thing, for the eyes to behold the light, the moon, at her full, by a course of unintermitted waiting, never fails to give us, as it were, a double day. How apparently has the divine wisdom interested itself, in providing even for the pleasurable accommodation of man !"

moon; for the distance is the same between the earth and the moon, as between the moon and the earth.

But, says the marchioness, is the earth as fit to send back the light of the sun as the moon is? You are altogether for the moon, said I; she is much obliged to you; but you must know that (3) light is made up of certain little balls, which rebound

(3) *Light is made up of certain little balls.*] This hypothesis, how ingenious soever, is now discarded, since the great discoveries made by Sir Isaac Newton, on the nature of light. He says, the rays of light are small corpuscles or bodies, emitted with exceeding celerity from the luminous body, with a force sufficient to enable them to move, at the inconceivable rate of 10,000,000 miles in a minute. The wonderful divisibility of the particles of matter is no where more apparent, than in the minuteness of the particles of light. Dr. Nieuwentyt has computed, that an inch of candle becomes divided into 269,617,046⁴⁰ parts. The expansion and extension of any portion of light is inconceivable. Dr. Hooke shews, it is as unlimited as the universe; proving it from the immense distance of some of the fixed stars, the light of which becomes sensible to the eye, by means of a telescope, when not visible without one. Nor, adds he, is it only the great bodies of the sun and stars, that are thus able to disperse their light thro' the vast expanse of the universe; but the smallest spark of a lucid body must do the same, even one struck from a flint by steel.

Dr. Gravesand asserts, a lucid body to be that which emits or gives fire a motion in right lines; and makes the difference between light and heat to consist in this, that to produce the former, the fiery particles must enter the eye, in a rectilinear motion, which is not required in the latter: on the contrary, an irregular motion seems the most proper for it, as appears from the rays coming directly

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bound from what is solid; and return obliquely; but pass thro' what admits of an entrance in a right line, as air or glass: so that what makes the moon enlighten us, is, that she is a firm and solid body, from which the little balls rebound; and we must deny our senses, if we will not allow the earth the same solidity: admire, therefore, what it is to be advantageously situated: because the moon is at so vast a distance from us, we can only discover her to be a body of light, and do not perceive that she is a great mass, altogether like the earth: whereas, on the contrary, because we are so near the earth, we know her to be a great mass, proper for the furnishing provision for animals; but do not discover her to be a body of light, for want of being placed at a due distance from her. It is just so with us all, says the lady; we are dazzled with the quality and fortune of those who are above us; when, if we did but examine things nicely, we should find the whole to be extremely alike.

It is the very same thing, says I; we would judge of all things, but yet stand in the wrong place; we are too near to judge of ourselves, and too far off to know others: so that the true way

to
rectly from the sun, to the tops of mountains, which have not near that effect with those in the valley, agitated with an irregular motion, by several reflections. But whether or no there be always light where there is fire, is disputed among authors; as also, whether or no there be any luminous body without heat. To give the reader an account of the different arguments on each side, would transgress the limits of these notes.

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to see things as they are, is to stand between the moon and the earth, and to be a mere spectator of this world, and not an inhabitant. I shall never console myself, says she, for the injustice we do the earth, and the too favourable opinion we have of the moon, till you assure me, that the inhabitants of the moon are as little acquainted with their own advantages as we are with ours; and that they take our earth for a planet, without knowing theirs is one too. Do not doubt it, answered I; we appear to them to perform very regularly our functions of a planet: it is true, they do not see us make a circle round them, but that is no great matter. Observe how this is done: that half of the moon which was turned towards us at the beginning of the world, has been turned towards us ever since; and those spots in her, which we have fancied look like a face, with eyes, nose and mouth, are still the same; and if the other opposite half should appear to us, with other spots, differently arranged, we should, no doubt, fancy some other figure: not but that the moon turns upon herself, and in the same time that she turns round the earth, that is, in a month; but while she is making that turn upon herself, and that she should hide a cheek, for example, of this pretended visage, and appear somewhat else to us, she makes, exactly, a like part of her circle round the earth, and still presents to us the same cheek; so that, if the moon, in respect of the sun and stars, turns round upon herself, in respect of us, she does not turn on her axis at all: they

also

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also seem to her to rise and set in the space of fifteen days; but for our earth, it appears to her to be suspended in the same place of the heavens. It is true, this apparent immobility is not very agreeable to a body which should pass for a planet; but this is not altogether perfect; (4) the moon has a kind of libration or trembling, which causes a little corner of her face to be sometimes hid from us, and a little corner of the opposite half appears; but then, upon my word, she attributes that trembling to us, and fancies that we have in the heavens the motion of a pendulum, which vibrates to and fro.

I find,

(4) *The moon has a kind of libration or trembling.*] This motion of the moon, gives her the appearance of wavering upon her axis, sometimes from east to west, and sometimes from west to east. Hence it is, that some parts of the moon's margin, or western limb, at one time recede from the center of the disk; and at another move towards it: by which means, some of those parts which were before visible, set and hide themselves in the invisible side of the moon, and afterwards become again conspicuous.

This libration is owing to her equable rotation round her axis, and her unequal motion in the perimeter (or circle) of her orbit: for if she moved in an exact circle, whose center coincided with the center of the earth, and turned round on her axis in the precise times of her period round the earth; the plane of the same lunar meridian would always pass through the earth, and the same face of the moon would be constantly and exactly turned to us. But since the real motion of the moon is an ellipsis or oval, in whose focus is the earth, and the motion about the earth is equable, or, which is the same thing, every meridian of the moon, by the rotation, describes angles, proportional to the times; the plane of no one meridian will constantly pass through the earth.

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I find, says the marchioness, the planets are just like us; we cast that upon others which is only in ourselves. Says the earth, 'It is not I that turn, it is the Sun.' Says the Moon, 'It is not I that tremble, it is the Earth.' The world is full of error: but I would not advise you, madam, to undertake the reforming it; you had better proceed to convince yourself of the entire resemblance of the earth and the moon: imagine then these two great globes suspended in the heavens; you know that the sun always inlightens the one half of a body that is round, and the other half remains in the shadow; there is then one half of the earth, and one half of the moon, which are inlighten'd by the sun; that is, one half, which is day, and the other half, which is night. Observe also, that as a ball has less force and quickness after it has been struck against a wall, and rebounds on the other side, so is light weakned when it is reflected by another body. The pale light, which comes to us from the moon, is the very light of the sun, but it cannot come to us from the moon, but by reflexion: it has, therefore, lost much of the force and lustre it had when it came directly from the sun upon the moon; and that bright light, which shines directly upon us from the sun, and which the earth reflects upon the moon, is a pale and weak light when it arrives there; so that the light which appears to us in the moon, and inlightens our nights, proceeds from that part of the moon which has day; and that part of the earth which

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has

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has day, when it is opposite to the part of the moon which has night, gives light to it also. (5) All depends upon the manner how the moon and the earth behold one another. At the beginning of the month we do not see the moon, because she is between the sun and us; and she, in the day, proceeds with the sun. It must necessarily happen then, that half of her which has day, is then turned towards the sun; and that half which has night, is turned towards us; we cannot see it then, because it has no light upon it; but that half of the moon which has night, being turned to that half of the earth which has day, sees us, without being herself perceived, and we then appear to them, just as the full moon does to us; so that, as I may say, the inhabitants of the moon have then a full earth; but the moon, being advanced upon her circle of a month, comes from under the sun, and begins to turn towards us a little corner of that half which is light, and appears in the form of a crescent; then, also, those parts of the moon which have night, begin to lose part of that half of the earth which has day; and we are then in the wain to them, or decreasing.

I understand you perfectly, says the marchioness, without hesitation; there is no occasion to say any more on this head; I can comprehend the rest at pleasure, and I have nothing to do but think
a moment,

(5) *All depends upon the manner how the moon and the earth behold one another.*] See this amply explained in a foregoing note, page 41.

a moment, and lead the moon through her circle of a month. I see, in general, that the inhabitants of the moon have a month quite contrary to us; when we have a full moon, their half of the moon which is light, is turned to our half of the earth which is dark; and when they do not see us at all, they have then a new earth; this is plain. I would not stand the reproach of requiring a long explication of so easy a point. But now tell me, how come the eclipses? You may easily guess at that, madam, replied I. When it is new moon, she is between the sun and us, and all her dark half is turned towards us who have light; (6) that obscure shadow is cast upon us: if the moon be directly under the sun, the shadow hides him from us, and, by that means, obscures a part of that half of the earth which is light; this is seen by that half of the moon which is dark: here then is an eclipse of the sun to us during our day, and an eclipse of the earth to the moon during her night. When it is full moon, the earth is between her and the sun, and all the dark half of the earth is turned towards all the light half of the moon; the shadow then of the earth casts itself towards the moon, and if it falls on the moon, it obscures that light half which we see, which then has day, and hinders the sun from shining on it: here then

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is

(6) *That obscure shadow is cast upon us.*] A shadow is not any real thing; it is only a privation of light, occasioned by any solid body, which is not transparent, intercepting the rays of light, and not permitting them to pass any farther.

is an eclipse of the moon to us during our night, and an eclipse of the sun to the moon during her day: but the reason that we have not eclipses every time that the moon is between the sun and the earth, or the earth between the sun and moon, is, because these three bodies are not exactly placed in a right line, and, by consequence, the body which should otherwise make the eclipse, casts its shadow a little beside that which should be obscured.

I am greatly surpris'd, says the marchioness, that there should be so little mystery in eclipses, and that the whole world should not know the cause of them. Ah! truly, answered I, there are many people in the world, who, in the manner they take things into their understandings, will be a long time before they can guess at it. In the East Indies, when the sun and the moon are in eclipse, they believe a certain dæmon, who has very black claws, is seizing on those planets with his talons; and during that time, the rivers are covered with the heads of Indians, who are up to the neck in water, because they esteem it a very devout posture, to implore the sun and moon to defend themselves well against this dæmon. In America, they are persuaded that the sun and moon, when eclipsed, are angry: and what is it they will not do to be reconciled with them? The Greeks, who were so refined a people, for a long time, believed the moon was then enchanted, and that the magicians forced her to descend from heaven, and shed a malignant juice on the plants; nay, what a panick were we in, not many years ago,

ago, at an eclipse of the sun that happened, when people hid themselves in cellars, and all the philosophers, who treated of its cause, could not persuade them to come out till the eclipse was over?

In good truth, says the lady, it is scandalous for men to be such cowards; there ought to be a law made to prohibit the discoursing of eclipses, that we might not perpetuate the memory of such follies, as have been occasioned thereby. Your law then, says I, must also abolish even the memory of every thing, and forbid us to speak at all; for I know nothing in the world which is not a monument of the folly of man, in some sort or other.

But what do you think, adds she, of the inhabitants of the moon; are they as fearful of an eclipse as we are? it would be a very good jest to see the Indians there up to the neck in water; that the Americans should believe the earth angry with them; the Greeks fancy we were bewitched, and would poison their plants; in short, that we should cause the same consternation among them, as they do among us. Why not, madam, I do not at all doubt of it; why should the people in the moon have more wit than we? what right have *they* to fright us, and not we *them*? for my part, continued I, laughing, I believe, that since a prodigious company of men have been, and still are, such fools to adore the moon, there certainly are people in the moon who worship the earth, and that we are reciprocally, upon our knees, the

one to the other. But sure, says she, we do not pretend to send any influences to the moon, (7) and to give a crisis to her sick ; if the people have any wit in those parts, they will soon destroy the honour we flatter ourselves with, and, I fear, we shall have the disadvantage.

Madam, says I, pray fear not any thing ; it is not probable that we are the only fools of the universe ? is it not common for ignorance to spread itself every where ? it is true, we can only guess at the folly of the people in the moon, but I no more doubt of it than I do the most authentic news that comes from thence. What authentic news comes from thence, says she ? That which the learned report, replied I, who travel thither every day with their telescopes ; they will tell you of their discoveries there, (8) of lands, seas, lakes, high mountains, and deep abysses. You surprise me, indeed, answered she ; I fancy they may discover

(7) *And to give a crisis to her sick.*] On this head, the learned reader is referred to the late Dr. Mead's work, intituled, *De Imperio Solis & Lunæ*.

(8) *Of lands, seas, lakes, high mountains, and deep abysses.*] The majority of the learned do not now allow of seas and lakes in the moon. Keil observes, that if the surface of the moon was plain and smooth, like a looking-glass, it would not reflect light but only in one point ; but being uneven, it diffuses the light by reflecting it to all sides. Besides these inequalities, there are upon her surface prodigious high mountains and deep vallies ; for when a half moon is viewed through a good glass, we do not find that the dark and light sides are divided by a strait line, but, on the contrary, this line is indented and cut very irregularly ; and even in the dark part,

cover mountains and abyſſes in the moon, becauſe of the remarkable inequalities in her; but how do they diſtinguiſh lands and ſeas? Very eaſily, Madam; for the waters letting part of the light paſs through them, ſend back but a very little, ſo that they appear aſar off like ſo many dark ſpots; whereas the lands, being ſolid, reflect the whole light, and appear to be more bright and ſhining. The illuſtrious monſieur Caſſini, a moſt complete aſtronomer, has diſcovered in the moon ſomething which divided into two parts, then reunited, and ſeemed to be ſunk in a kind of well: we may, very probably, ſuppoſe this was a river. Nay, they pretend to be ſo well acquainted with the ſeveral places, that they have given them all names from the learned: one place they call Copernicus, another Archimedes, and a third Galileo;

D 4

leo;

part, near the lucid ſurface, there are ſeen ſome ſmall places enlightened by the ſun's beams; and upon the fourth day after new moon, ſome bright points, like rocks or iſlands, may be perceived ſhining within the dark body of the moon. Now it is impoſſible this ſhould be, unleſs theſe ſhining points were higher than the reſt of the ſurface, ſo that the light of the ſun may reach them. Theſe then are the tops of mountains, which riſing far above the other parts of the ſurface, are ſooner reached by the ſun's beams, and remain longer in the light, than the reſt of the parts do which are lower. Beſides theſe, we ſee many dark ſpots in the illuminated part of the moon, which ſeem to be only caverns, or deep hollows; on which the ſun ſhining very obliquely, and touching only their upper edge with his light, the deeper places remain dark; but as they turn towards the ſun, they receive more light, and the dark ſhadows grow ſhorter; till the ſun comes to ſhine directly down into them; and then

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leo; there is the promontory of dreams, a sea of
tears, a sea of nectar; in short, they have publish-
ed such exact descriptions of the moon, that if one
of the learned was there, he would be no more
at a loss to seek his way, than I am in Paris.

I must own then, says the marchioness, they
are very exact; but what do they say to the inter-
nal part of the country; I would very fain know.
That is impossible; replied I; for even the gentle-
men of the Observatory cannot inform you. You
must ask Astolfo this question, who was carried
into the moon by St. John. I am going to tell
you one of the agreeable follies of Ariosto, which,
I am sure, you will be pleased to hear. I must
confess he had better have left St. John alone, whose
name is so worthy of respect; but it is only a poe-
tical license, and, on that account, may be allowed.
The poem, which is called ORLANDO FURIOSO,
is dedicated to a Cardinal, and a great Pope has
honoured it with his approbation, which is pre-
fixed

then the whole cavity will be illustrated, and these ob-
scure parts will look as bright as the tops of the moun-
tains. These are vastly higher than our earthly moun-
tains. Geometers can take the height of them as easily
as they can find the altitude of a mountain on the earth.
For the method, those who are versed in geometry, may
apply to Keil, Lect. x. p. 107, and to Derham's Astro-
theology, p. 120. Lond. 1721.

We have given a representation of the face of the full
moon in plate III. as represented by Hevelius, whose
lunar geography is justly the most followed. The ap-
pearance of the moon's edge, or strait line, which di-
vides the enlightened from the dark part soon after the
quadrature, is very rough and indented, when examin-
ed with an ordinary telescope; and confirms what has
been said above concerning the unevenness of her surface.

fixed to several editions of the work: this is the Argument.

‘ Orlando, nephew to Charlemagne, runs mad,
 ‘ because the fair Angelica prefers Medone to him.
 ‘ Astolfo, a knight-errant, finding himself one day
 ‘ in the Terrestrial Paradise, which was upon the
 ‘ top of a very high mountain, where he was
 ‘ carried by his flying horse, being half horse and
 ‘ half griffin, meets St. John there, who tells him
 ‘ if he would have Orlando cured, he must make
 ‘ a voyage with him into the Moon. Astolfo,
 ‘ who had a great mind to see new countries, did
 ‘ not stand much upon intreaty; there immediately
 ‘ came a fiery chariot, which carried the Apostle
 ‘ and the Knight-errant up into the air: Astolfo,
 ‘ being no great philosopher, was surprized to
 ‘ find the moon so much bigger than it appeared
 ‘ to him when he was upon the earth: he was
 ‘ yet much more surprized, to see other rivers,
 ‘ other lakes, mountains, cities, forests; nay,
 ‘ what would have surprized me too, nymphs
 ‘ hunting in those forests; but that which appear-
 ‘ ed most remarkable, was a valley (9) where you
 ‘ might find any thing that was lost in our world,
 D 5. ‘ of

(9) *Where you may find any thing that was lost in our world.*] Mr. Pope, in the Rape of the Lock, canto 5, has made an excellent use of this notion of Ariosto, which seems much more proper for a mock-heroic poem, than for a true epic.

Some thought it mounted to the lunar sphere,
 Since all things lost on earth are treasur'd there.

There.

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‘ of what nature soever ; crowns, riches, fame,
 ‘ and an infinity of hopes : the time we spend in
 ‘ play, and the alms we give after our death ; the
 ‘ verses we present to princes, and the sighs of
 ‘ lovers.’

I do not know, says the marchioness, what became of the sighs of lovers in Ariosto’s time, but I fancy there are very few of them ascend to the moon in our days. Ah, madam, replied I, how many does your ladyship send thither every day ? I assure you, the moon keeps all safe that is lost here below : yet I must inform you, Ariosto, tho’ he does but whisper it, tells us that every thing is there, even the donation of Constantine (the Popes having pretended to be masters of Rome and Italy, by virtue of a donation which the Emperor Constantine made to Pope Silvester ; and the truth of it is, no body knows what is become of it :) but what do you think that thing is, which is not to be found in the moon ? Folly. All that ever was upon the earth is kept there ; and, in lieu of the want of it originally, it is not to be imagined how many wits (if I may so call them) that are lost here, are got up into the moon. They are so many phials full of a very subtile liquor,

There heroes’ wits are kept in pond’rous vases,
 And beaus’ in snuff-boxes and tweezer-cases.
 There broken vows, and death-bed alms, are found,
 And lovers’ hearts with ends of ribband bound.
 The courtiers’ promises, and sick men’s pray’rs,
 The smiles of harlots, and the tears of heirs,
 Cages for gnats, and chains to yoke a flea,
 Dry’d butterflies, and tomes of casuistry.

liquor, which evaporates immediately, if it be not well stopped; and upon every one of these phials the names are written of the persons to whom the wits belong: I think Ariosto has heaped them upon one another a little confusedly, but, for order's sake, we will fancy them placed upon shelves in a long gallery; Astolfo wondered to see several phials full, inscribed with the names of persons whom he thought considerable for their wisdom. To confess the truth, I begin to fear, since I have entertained you with these philosophical and poetical visions, mine there is not very empty; however, it is some consolation to me, that while you are so attentive, you have a little glass full in the moon as well as your humble servant: the good Knight found his own wits among the rest, and with St. John's leave, snuffed it all up his nose, like so much Hungary-water; but Ariosto said he did not carry it far, it returned again to the moon, through a folly he had committed a little after.

Well, he did not forget Orlando's phial, which was the occasion of his voyage; but he was cursedly plagued to carry it; for these heroes' wits were naturally very heavy, and there did not want one drop of it: to conclude, Ariosto, according to his laudable custom of saying whatever he pleases, addresses himself to his mistress in beautiful verses, whose purport are as follow.

' Who shall ascend to the heavens, my fair
' one, to recover those senses your charms have
' deprived me of? I shall not complain of this
' loss, provided it goes no further; but, should
' things

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things continue in the same manner they have begun, I have nothing more to expect, but that I shall become myself such a Furioso as I have described Orlando.

I do not, however, believe, that to restore me to sense, there is any occasion for me to make a voyage through the air, or go so far as to the moon. My scattered wits are not lodged so high; they are wandering on your eyes and on your mouth; and, if you will permit me to recover them, suffer me to collect them together from thence, with my lips.' (10)

Is not this very fine? for my part, to reason like Ariosto, I think, the safest way of losing our wits, is, to be in love; for you see they do not go far from us; we may recover them again at our lips; but when we lose them by other means, as we at present, for example, by philosophizing, they are flown into the moon, and there is no coming at them again when we would. However, says the marchioness, our pupils shall have an honourable rank among the philosophers; when, on the contrary, had they been wandering here, they might have fixed upon some object unworthy of them: but to take away mine entirely, pray tell me very seriously, if you believe there are men in the moon; for, methinks, hitherto, on that article, you have not been very positive.

For

(10) The author has given the above in prose, which we have also chosen to do, rather than the very bad versification of Sir John Harrington inserted in the former translation.

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For my part, says I, I don't believe there are any men in the moon : do but observe how much the face of nature is changed between this and China ; other visages, shapes, manners ; nay, almost other principles of reasoning ; and, therefore, between us and the moon the alteration must be much more considerable. When we arrive in certain lands, that have been lately discovered, we can scarce call the inhabitants men, they are rather animals in human shape, and that too sometimes very imperfect, almost without human reason ; he therefore who will travel to the moon, must not expect to find men there.

What sort of people are they then, says the lady, with an air of impatience ? In good faith, Madam, replied I, I do not know ; for, put the case that we ourselves inhabited the moon, and were not men, but rational creatures ; could we imagine, do you think, such fantastical people to dwell upon the earth, as mankind are ? is it possible we should have an idea of so strange a composition, a creature of such foolish passions, and such wise reflections ? allotted so small a span of life, and yet pursuing views of such extent ? so learned in trifles, and so stupidly ignorant in matters of the greatest importance ? so much concerned for liberty, and yet have such great inclinations to servitude ? so desirous of happiness, and yet so very incapable of attaining it ? The people in the moon must be wise, indeed ; to suppose all this of us. But do not we see ourselves continually, and yet we cannot so much as guess how we were made ?
so

so that some have gone so far as to say, the Gods, when they created us, were drunk with nectar; and when they were sober again, could not chuse but laugh at their own handy-work. Well, well, says the marchioness, then we are safe enough; the inhabitants of the moon can never guess at us, but I could wish we were a little better acquainted with them; for it troubles me that we should see the moon above us, and yet not know what is done therein. Why, says I, are not you as much concerned for that part of the earth called Terra Australis, which is not yet discovered? what creatures inhabit it, and what they do there? for we and they are aboard the same ship; they possess the prow, and we the poop, and yet there is no manner of communication between us; they know not at one end of the vessel, who lives there, or what is done at the other; and you would know what passes in the moon, which is another great ship, sailing in the heavens at a vast distance from us.

Oh, says she, as for the inhabitants of the Terra Australis, I reckon them all as good as discovered, and can guess at these people, though I never heard a word of them. It is certain, they all must very much resemble us, and we may know them better whenever we please. They must always stay where they are, and cannot escape from us: it is only going to see them when we will; but we cannot get into the moon, if we would; so that I despair of knowing what they do there. You will laugh at me, says I, if I should answer you.

you seriously ; perhaps I may deserve it, and yet, I fancy, I can say a great deal in defence of a whim that is just now come into my head ; which has an air of probability that surprizes me. I know not from whence it has taken its rise, it is so impertinently odd. But I will lay a wager that I'll make you own, in spite of your reason, that one of these days there may be a communication opened between the earth and the moon. Do but consider the situation the inhabitants of America were in, before it was discovered by Columbus, how profoundly ignorant were those people ; far from being acquainted with the sciences, they did not know the most simple and most necessary arts ; they went naked, had no other arms but bows, and did not apprehend that men might be carried by animals ; they looked upon the sea as a wide space, that men were forbid to pass ; but thought it was joined to the heavens, and beyond it was nothing : it is true, that after having spent whole years in hollowing the trunk of a great tree, with sharp stones, they put themselves to sea in this trunk, and floated from land to land, as the wind and waves drove them ; but how often was their canoe overset, and they forced to recover it again by swimming ? so that, except when they were on land, it might be said they were continually swimming : and yet, had any one but told them of another kind of navigation, incomparably more perfect and useful than their own, that would easily convey them over that infinite space of water, to any part, and in any manner that they pleased ; that they

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they might stop in the middle of the waves, and, in some sense, command the winds; in short, that this vast ocean should be no obstacle to their conversing with another different people beyond the sea; do you think they would have believed you? and yet at last the day is come, when, an unheard of, and most surprizing sight appears; enormous bodies, which seem to have white wings, are seen to fly upon the sea; to vomit fire from all parts; and to cast on their shores an unknown people, scaled over with iron; who dispose and govern monsters as they please, carry thunder in their hands that destroys whoever resists them: from whence came they? who hath brought them over the sea? who gave them the disposal of this fire? are they gods? are they the offspring of the sun? for certainly they are not men. (11)

Do

(11) We think ourselves obliged, in justice to the memory of monsieur Fontenelle, to observe in this place, that Mr. Dryden's celebrated description of a ship was taken from our author; the Plurality of Worlds being written by him, and translated by Mrs. Behn, some years before the Indian Emperor was brought upon the stage.

Compare the above description of Fontenelle with Dryden's, as it here follows.

The object I could first distinctly view;
Was tall strait trees which on the waters flew;
Wings on their sides, instead of leaves, did grow,
Which gather'd all the breath the winds could blow,
And at their roots grew floating palaces,
Whose out-blow'd bellies cut the yielding seas.
All turn'd their sides, and to each other spoke:
I saw their words break out in fire and smoke.
Sure 'tis their voice that thunders from on high,
Or these the younger brothers of the sky.

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Do but consider with me, madam, the surprize and wonder of the Americans; sure there can be nothing greater; and after this, I will not swear but there may be a communication, in time, between the moon and the earth. Did the Americans believe there would ever be any between them and Europe? a country they never heard of! It is true, that we must pass this great space of air, and part of the heavens, which is between the earth and the moon; but did not those vast seas seem at first as impassible to the Americans? You rave, I think, says she? Who denies it, Madam, said I. Nay, but I will prove it, replied she; I do not care for your bare owning it: did you not own the Americans were so ignorant that they had not the least conception of crossing the sea; but we, who know a great deal more than they, can imagine and fancy a method of going through the air, if we were assured it was to be done.

It is somewhat more than fancy to suppose it possible; we already begin to fly a little, replied I; for several people have found the secret of fastening wings to themselves, which bear them up in the air, to move them as they please, and to fly over rivers. I cannot say, indeed, they have yet made an eagle's flight, or that it does not cost now and then a leg or an arm to one of these new birds; but this may serve to represent the first planks that were laid on the water, and which were the beginning of navigation; there were no vessels then thought of to sail round the world in,
and

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and yet you see what great ships are grown, by little and little; from those rude planks. (12) The art of flying is but newly invented; it will improve by degrees, and in time grow perfect; then we may fly as far as the moon. We do not yet pretend to have discovered all things, or that what we have discovered can receive no addition; and therefore, pray let us agree, there are yet many things to be done in the ages to come. I will never consent to this, said she, that mankind will carry the art of flying to that perfection, but that they will immediately break their necks. Very well, answered I; if you insist upon it, that mankind will be always such bad flyers, they may fly better in the moon; it is no great matter whether we go to them, or they come to us; we shall then be like the Americans, who knew nothing of navigation, and

(12) *The art of flying is but newly invented.*] This art is one of the great things wanted in mechanics, attempted in divers ages; the discovery whereof might prove of great service and disservice to mankind. No body ever bid so fair for this invention as the famous fryar Bacon, who lived more than 500 years ago. He not only affirms the art feasible, but assures us, he himself knew how to make an engine, in which, a man sitting, might be able to carry himself through the air, like a bird; and affirms, that there was another person, who had actually tried it with success. The secret consisted in a couple of large thin hollow copper globes, exhausted of air; which being much lighter than air, would sustain a chair whereon a person might sit. Father Francisco Lana, in his Prodomo, proposes the same thing, as his own thought; he computes, that a round vessel of plate-brass, 14 feet in diameter, weighing 3 ounces the square foot,

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and yet there were very good ships at the other end of the world. Were it so, says she, in a sort of a passion, the inhabitants of the moon would have been here before now. All in good time, says I; the Europeans were not in America till about the end of 6000 years; so long were they in improving navigation to the point of crossing the ocean. The people in the moon may have already made some short voyages in the air; they may be now exercising continually, and by degrees will be more expert, and when we see them, God knows how we shall be surprized. It is unsufferable, says she, you should push things so far, and justify your ridiculous fancy by such false reasoning. I am going to demonstrate, says I, that you reproach me very unjustly: consider, madam, that the

foot, will only weigh 1848 ounces; whereas a quantity of air of the same bulk, will weigh $2155\frac{1}{2}$ ounces: so that the globe will not only be sustained in the air, but will carry with it a weight of 373 ounces; and by increasing the bulk of this globe, without increasing the thickness of the metal, he adds, a vessel might be made to carry a much greater weight. But the fallacy is obvious; a globe of the dimensions he describes, Dr. Hooke shews, would not sustain the pressure of the air, but be crushed inwards. Besides, in whatever proportion the bulk was increased, in the same proportion must the thickness of the metal be increased likewise; and consequently the weight also: so that there would be no advantage in such augmentation.

The same author describes an engine for flying, invented by the Sieur Besnier, a smith of Sable, in the county of Maine, in France. [See Hooke's Philosoph. Collections, No. 1.] Bishop Wilkins, in his Mathematical

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 the knowledge of the world is unfolded by degrees; for the ancients were very positive, that both the torrid and frigid zones were not habitable, by reason of their excessive heat and cold; and in the time of the Romans, the general map of the world was but very little extended beyond that of their own empire; which, though, in one respect, it expressed much grandeur; in another sense, was a sign of as great ignorance: however, there were men found both in very hot and in very cold countries; so that you see the world is already increased. After this, it was thought that the ocean covered the whole earth, except what was then discovered; (13) there was no talk of the antipodes,

cal Magic, has given an ample account of the various attempts of mankind to carry on this art, to which work the reader is referred for many curious particulars relative thereto.

Our author seems to have spoken rather by way of amusement, than in earnest, as to flying to the moon; for he himself has afterwards, in the third conversation, given an unanswerable objection to it; viz. the different quality of our air, and the atmosphere of the moon, if she has any; for we cannot exist at the top of an high mountain, where the air is very subtle. Besides, by gravity we naturally tend towards the earth; and we do not see how it is possible to get beyond the power of its attraction; and if we did, an heavy body would then tend towards the sun, whose power may, beyond the sphere of the earth's attraction, be far superior to that of the moon. The height which large birds fly to, is but inconsiderable, when compared to that of the atmosphere; nor is it to be supposed, that the thin air or æther of the upper regions, hath sufficient energy even to support a small fowl.

(13) *There was no talk of the antipodes.*] These are people

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tipodes, nor so much as a thought of them; for who could fancy their heels at top, and their heads at bottom? and yet, after all their fine reasoning, the antipodes were discovered: here is now another half of the world starts up, and a new reformation of the map. You well understand me, madam; these antipodes have been discovered, contrary to expectation: ought we to be under the least apprehension that we are arrived at the ultimate point of human knowledge? the world will unfold itself, perhaps, more to us hereafter; we know the road to the moon, but we are not yet got there; all things must be done in order, the whole earth must be first discovered; and till we are perfectly acquainted with our own habitation, we shall never know that of our neighbours, the people of the moon. Without fooling, says the marchioness, looking earnestly upon me, you are so very profound in this point, that I begin

people on opposite sides of this globe, whose feet are towards ours; and their heads, relative to us, downwards. The centre is, in reality, the lowermost point of the earth, which, could we dig so far, we could descend no further; for to proceed, we must from that point ascend. And was it possible to bore an hole through the globe, from surface to surface, a stone dropped in at either end, would at length rest at the centre. In the same manner every person and thing, on any part of this globe, gravitates towards the centre.

Plato is said to have first started the notion of the antipodes; and indeed, as he conceived this globe to be a sphere, it was easy for him to infer, that there must be antipodes. Lactantius and St. Augustine, laughed at this notion. Boniface, archbishop of Mentz, and legate
of

begin to think you are in earnest, and that you believe all you say on this subject. Not so, neither, says I; but I would shew you, madam, how easy it is to maintain a chimerical notion, that may perplex persons of understanding, but never convince them; there is not any argument so persuasive as truth, which has no need to exert all its proofs. Truth enters so naturally into the mind, that when we learn any thing for the first time, it appears as if we only remembered the thing learned, or exerted the faculty of our memory. I thank you then, says she, for imposing on me no longer; for I confess your false reasoning disturbed me, but now I shall sleep very quietly, if you will be so obliging as to retire for to-night.

The

of pope Zachary, in the 8th century, declared a bishop of that time, one Virgilius, an heretic, for maintaining this doctrine. History also informs us, that Spigellus, bishop of Upsal, suffered martyrdom at the stake, for defending the notion of the antipodes. And, indeed, the christian fathers were not the only persons that disputed this truth, which every sailor is now convinced of. Lucretius has done it long before them, at the end of his first book, v. 1063. &c. See also Plutarch, *lib. de facie in orbe lunæ*; and Pliny, who endeavours to refute this opinion, *lib. ii. cap. 65.*



THE THIRD EVENING.

*Particulars concerning the WORLD in the MOON,
and proofs of the other PLANETS being habitable.*

THE marchioness would fain have engaged me, during the next day, to proceed where I left off; but I told her, since the moon and stars were become the subject of our discourse, we should trust our reveries with nobody else; at night, therefore, we went again into the park, which was now wholly dedicated to our learned conversations.

Well, madam, says I, I have great news for you; that which I told you last night, of the moon's being inhabited, according to all appearances, may be otherwise now. There is a new fancy got into my head, which puts those people in great danger. I cannot, says her ladyship, suffer this. Yesterday you were preparing me to receive a visit from the lunarians, who might one day come here; and now you would insinuate there are no such folks. You must not trifle with me thus; you have made me believe the moon was inhabited; I surmounted the difficulty I had to imagine it, and do now believe it. You are a little too quick, replied I; we ought to reserve
half

half of our assent free and disengaged, that we may admit of a contrary opinion, if there should be occasion. I am not satisfied with this, says she; must we not reason concerning the moon as a Parisian might about St. Dennis? No, says I, the moon does not so much resemble the earth, as St. Dennis does Paris: the sun draws vapours from the earth and exhalations from the water, which mounting to a certain height in the air, do there assemble, and form clouds; these suspended clouds are driven irregularly round the globe, sometimes shadowing one country, and sometimes another; he then who beholds the earth from afar off, will see frequent alterations upon its surface, because a great country, overcast with clouds, will appear dark or light, as the clouds stay, or pass over it; he will see spots on the earth, which often change their place, and appear or disappear as the clouds remove; we should see therefore these changes wrought upon the moon, if there were any clouds about her; yet on the contrary, all her spots are fixed, and her light parts continue always the same, here lies the difficulty; for by this reason, we know the sun never draws any exhalations or vapours above the moon; so that it appears she is a body infinitely more hard and solid than the earth; whose subtle parts are easily separated from the rest, and mount upwards as soon as heat puts them in motion: hence, we necessarily conclude that the moon must be a heap of rock and marble, where no evaporation can arise; besides,

sides, exhalations so naturally and necessarily arise where there is water, that there can be no water at all, where there is no exhalation; and what sort of inhabitants must those be, whose country affords no water, is all rock, and produces nothing? This is very fine, says the marchioness; you have forgot since you assured me, that the learned from hence distinguish seas in the moon. All conjecture, madam, replied I, though for your ladyship's sake, I am very sorry for it; for those dark places we took to be seas, may perhaps be nothing but large cavities; it is hard to guess right at so great a distance. But will this suffice then, says she, to extirpate the people in the moon? Not altogether, replied I, we will neither determine for nor against them. I must own my weakness, (if it be one) says she, I cannot be so perfectly indifferent as you would have me to be, but must believe one way or other; therefore, pray fix me quickly in my opinion, as to the inhabitants of the moon; preserve or annihilate them, as you please; and yet methinks, I have a strange inclination for them, and would not have them destroyed, if it were possible to save them. You know, says I, madam, I can deny you nothing; the moon shall be no longer a desert, but, to give you pleasure, we will re-people her. Since to all appearance the spots in the moon do not ever change, I cannot conceive there are any clouds about her, that sometimes obscure one part, and sometimes another; yet this does not hinder, but that the

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moon sends forth exhalations and vapours. The clouds, which we see in the air, are nothing but exhalations and vapours, which, at their coming out of the earth, were separated into such minute particles, that they could not be discerned; but as they ascend higher, they are condensed by the cold, and by the re-union of their parts, are rendered visible; after which they become great clouds, which fluctuate in the air, their proper region, till they return back again to us in rain: however, these exhalations and vapours sometimes keep themselves so dispersed, that they are imperceptible; or if they do assemble, it is (1) in forming such subtle dews, that they cannot be discerned to fall from any cloud. Now, as it seems incredible the moon should be such a mass, that all its parts are of an equal solidity, all at rest one with another, and all incapable of any alterations from the efficacy of the sun; I am sure we are yet unacquainted with such a body: marble itself is of another nature, and even that which is most solid, is subject to change and alteration, either from the secret and invisible motion it has within itself, or from that which it receives from without: it may so happen that the vapours which issue from the moon, may not assemble round her in clouds, and may not fall back again in rain, but only in dews. It is sufficient

(1) *In forming such subtle dews.*] Dews, in a great measure, ascend from the earth, as is now generally supposed; and as, in some sort, is visible after an hot day.

cient for this purpose, that the air with which the moon is surrounded (is particular to her, as well as that of the earth is to it) should some what vary from our air; and the vapours of the moon be a little different from those of the earth, which is very probable. Hereupon the matter being otherwise disposed in the moon than on the earth, the effects must be very different; though it is of no great consequence whether they are or no; for from the moment we have found an inward motion in the parts of the moon, or one produced by foreign causes, here is enough for the re-appearance of its inhabitants, and a sufficient and necessary fund for their subsistence. This will furnish them with corn, fruit, water, and what else we please to allow them; I mean according to the custom or manner of the moon, which I do not pretend to know; and all proportioned to the wants and uses of the inhabitants, with whom, I own, I am little acquainted.

That is to say, replied the marchioness, you know all is very well supplied, without knowing how it is so; which is a great deal of ignorance, founded upon a very little knowledge; however, I comfort myself, that you have restored the moon her inhabitants again, and have enveloped her in an air of her own, without which a planet would seem to me but very naked.

It is these two different airs, madam, that hinder the communication of the two planets; if it was only flying, as I told you yesterday, who knows but we might improve it to perfection

hereafter ? Though, I confess, there is but little hopes of it ; the great distance between the moon and the earth is a difficulty not easily to be surmounted ; yet were the distance but inconsiderable, and the two planets almost contiguous, it would be still impossible to pass from the air of the one, into the air of the other : water is the air of fishes, they never pass into the air of birds, nor the birds into the air of fishes ; and yet it is not the distance that hinders them, but both are imprisoned by the air they breathe in ; we find our air consists of thicker and grosser vapours than the air of the moon. So that one of her inhabitants, arriving at the confines of our world, as soon as he enters our air, will inevitably drown himself, and we shall see him fall dead on the earth.

I should rejoice, says the marchioness, to see a ship-wreck of a good number of these lunar people ; how pleasant would it be to behold them lie scattered on the ground, where we might consider, at our ease, their extraordinary figures ? But, replied I, suppose they could swim on the outward surface of our air, and be as curious to see us, as you are to see them ; should they angle, or cast a net for us, as for so many fish, would that please you ? Why not, says she, smiling ? For my part, I would go into their nets of my own accord, were it but for the pleasure of seeing such strange fishermen.

Consider, madam, you would be very sick, when you were drawn to the top of our air ; for
there

there is no respiration in its whole extent, (2) as is the case on the tops of some very high mountains: and I admire that they, who have the folly to believe that those Genii, whom they allow to be corporeal, and to inhabit the most pure and refined air, do not tell us, that the reason why they pay us such short and seldom visits, is, that there are very few among them who can dive; and those that can, if it be possible to get through the thick air where we are, cannot stay long below.

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(2) *As is the case, on the tops of some very high mountains.*] Concerning the surprising effects the rarefaction of the air hath upon human bodies, especially on the tops of very high mountains, particularly on the Cordilleroes, part of the Andes in Peru, esteemed the highest mountains in the world, the reader is desired to consult a late account published by Don John de Ulloa, who passed over them; and who informs us, that travellers are, on their tops, frequently seized with bleeding at the nose, vomiting, vertigoes, fainting, and other dangerous symptoms.

The loftiest summits of hills, and the most enormous ridges of mountains, are no real objection to the globular form of the earth. Because, however they may render it to our limited sight, vastly uneven and protuberant; yet, they bear no more proportion to the intire surface of the terraqueous ball, than a particle of dust, casually dropt on the mathematician's globe, bears to its whole circumference. Consequently the round figure is no more destroyed in the one case than in the other. And if such bad effects are produced at so very small an elevation as our highest mountains are, in respect of the rotundity of the earth, what must be the consequence, if we could possibly, by any contrivance, raise ourselves higher in the air?

Here then are the natural barriers, which defend the passage out of our world, as well as the entrance into the moon; and as we can only guess at that world, let us fancy all we can of it. For example, I will suppose that they must there see the firmament, the sun, and the stars, of another colour than what we see them; all these appear to us through a kind of natural optic glass, which changes and alters the objects. This is our air, mixed with vapours and exhalations, and which extends itself very high. Some of our modern philosophers pretend, that of itself it is blue, as well as the water of the sea, and that this colour neither appears in the one nor in the other, but at a great depth; the firmament, say they, where the fixed stars are placed, has no peculiar light of its own, (3) and by consequence must appear black; but we see it through the air,

(3) *And by consequence must appear black.*] DES. GRAV. V. II. p. 161, says, The heavens are nothing but an immense space which cannot be seen, and would appear black, if innumerable rays of light, flowing from the heavenly bodies, did not continually penetrate our atmosphere; most of them come to us from these bodies in right lines, yet a great many suffer various reflections in the atmosphere, and enlighten it all; which is the reason that, in the day, bodies are enlightened even without the reflection of the clouds, to which the solar rays cannot come directly.

Fontenelle might have drawn a kind of comparison from our torrid zone to have satisfied the marchioness: there the air is so much rarified by the sun's heat, that the finest sky we ever see in our northern climates, can never equal the splendor and beauty of the heavens, especially at night, in hot countries.

air, which is blue, and therefore to us it appears blue; which if so, the beams of the sun and stars cannot pass through the air without being tinged a little with its colour, and losing as much of their own; yet, were the air of no colour, it is very certain, that through a great mist, the light of a flambeau, at some distance, appears red, though it be not its true natural colour. Our air is nothing but a great mist, which changes the true colour both of the sky, sun, and stars; it belongs only to the celestial matter to bring us the light and colours as they really are, in all their purity; so that since the air of the moon is of another nature than our air, it is either in itself tinged with another colour, or at best is another kind of mist, which varies the colours of the celestial bodies; in short, as to the people of the moon, their medium, through which they see every thing, is changed.

If it be so, says the marchioness, I prefer this abode before that of the moon; I cannot believe the celestial colours are so well adjusted there as they are here; for instance, let us put green stars on a red sky, they cannot be so agreeable as stars of gold on an azure firmament. One would think, madam, you was chusing a petticoat, or a suit of ribands; but, believe me, nature does not want fancy; leave it to her to chuse colours for the moon, and I will engage they shall be well sorted; she will not fail to vary the prospect of the universe, at every different point of sight, and the alteration shall always be very agreeable.

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I know very well, says the marchioness, her skill in this point; she is not at the charge of changing the objects, but only the glasses, and has the credit of this great variety, without being at any additional expence: with a blue air, she gives us a blue firmament; and perhaps with a red air, she gives to the inhabitants of the moon a red firmament, and yet it is always but the same firmament; nay, I am of opinion, she has placed spectacles in our imagination, through which we see all things, and which to every particular man change the objects. Alexander looked on the earth as a fine place, fit to establish a great empire; it seemed to Celadon a proper residence for Astræa; and it appeared to a philosopher, a great planet travelling through the heavens, covered with fools; I do not believe the appearances of things vary more between the earth and the moon, than they do between the fancies of two different men.

This change in our imaginations, says I, is very surprising; for they are still the same objects, though they appear different; when in the moon, we may see other objects we do not see here, or, at least, not see all there, we do see here; perhaps, in that country they know not any thing of the dawn and the twilight, before the sun rises, and after the sun sets; the air which encompasseth, and is above us, receives the rays, so that they cannot strike on the earth; and, being gross, stops some of them, and sends them hither, though indeed they were never naturally

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turally designed us ; (4) so that the aurora and the twilight, are favours which nature bestows on us : they are lights which do not fall to our share, and which she gives us over and above our due ; but in the moon, where the air is apparently more pure, and therefore not so proper to send down the beams it receives from the sun before his rising, and after his setting, these poor wretches have not that light of grace (as I may call it) which, growing stronger by degrees, does more agreeably prepare them for

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(4) *So that the aurora and twilight, are favours which nature bestows.*] Besides many other advantages we have from the atmosphere, it makes the face of the heavens to appear bright while the sun shines ; for if no atmosphere surrounded the earth, only that part of the heavens would be enlightened where we saw the sun ; and if we turned our backs to him, we should see the other parts of the sky as black as at night, and the smallest stars would appear at noon day : then there would be no substance to reflect the solar rays to our eyes, and all the rays which did not fall on the earth's surface, passing by us, would either illuminate the planets and stars, or spreading themselves out into infinite space, would never be reflected back to us. But the atmosphere reflects the solar rays back upon us ; and makes the whole heavens to shine so strongly, that it obscures the stars, and renders their faint light invisible.

If there was no atmosphere, the moment after sunset, it would be as dark as at midnight ; so quick a change would be very inconvenient to us. But, by means of the atmosphere, our evenings and mornings are prolonged, and the darkness and light come on by insensible degrees : for the atmosphere being higher than the earth, is illuminated by the sun, though it be below the horizon, as the tops of edifices and high mountains,

are

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the arrival of the sun ; and (5) which, growing weaker and weaker, and diminishing by degrees, does insensibly prepare them for the sun's departure : but they are in a profound darkness, where a curtain (as it were) is drawn all on a sudden ; their eyes are immediately dazzled with the whole light of the sun, in all its glory and brightness ; so likewise, they are on a sudden enveloped with utter darkness ; the night and the day have no medium between them, but they fall in a moment from one extreme to another. The rainbow likewise is not known to the inhabitants of the

are enlightened by him in the same manner ; and it is the atmosphere that reflects the sun's light, both before he is risen, and after he is gone down ; but when he is 18 degrees lower than the horizon, he no longer enlightens our atmosphere, and then all that part thereof that is over us becomes dark. During part of the summer, in which the sun is not 18 degrees below the horizon, there is a continual twilight from sun-setting to sun-rising.

If we have the time of the beginning of twilight in the morning, or the end of it at night, we may find the height of the air that reflects the light ; for then the twilight ends, when a ray of light touches the globe of the earth, and is by the highest air reflected to our eyes ; having the time, we can find the depression of the sun below the horizon, and from thence the height of the air. Vide *Keil's lectures*, p. 235.

(5) *Which growing weaker and weaker, and diminishing by degrees, does insensibly prepare them for the sun's departure.*] Mr. Hervey, in his contemplations on the night, has very beautifully described the gradual approach of darkness. " The light of heaven, says he, " has almost finished his daily race, and hastens to the " goal. He descends lower and lower, till his chariot " wheels

the moon; for if the dawn is an effect of the grossness of the air and vapours, the rainbow is formed in the clouds, and from whence the rain falls; so that the most beautiful things in the world, are produced by those things which have no beauty at all. Since then there are no vapours thick enough, nor no clouds of rain about the moon, farewell the blushes of aurora, and the vivid colours of the rainbow: what must lovers do for similes to compare their mistresses to, in that country, when such an inexhaustible fund of similes is taken from them?

Nay, I shall never lay the loss of their similes much to heart, says the lady, and I think them well enough recompensed for the loss of our dawn, and rainbow; for by the same reason, they have neither thunder nor lightning, both which are formed in the clouds: how glorious
are

" wheels seem to hover on the utmost verge of day.
" And what is somewhat remarkable, his orb, upon the
" point of setting, grows broader: the shadows, just
" before they are lost in undistinguished darkness, are
" surprizingly lengthened.

" The radiant globe, is now, half-immersed beneath
" the dusky earth. He is taking leave of our hemi-
" sphere, and gilds the plains with a languid lustre.

" But, could I view the sea, at this juncture, it
" would yield a most amusing and curious spectacle.
" The rays, striking horizontally, on the liquid ele-
" ment, give it the appearance of floating glass; or
" reflected in many a different direction, form a beauti-
" ful multiplicity of colours.

" A stranger, as he walks along the sandy-beach,
" and, lost in pensive attention, listens to the murmur-
ings

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are their days, the sun continually shining? How pleasant their nights, when not the least star is hid from them? They never hear of storms or tempests, nor any of these things, which seem to us the plain effects of the wrath of heaven. Do you think then they stand in need of our pity? You are describing the moon, says I, like an enchanted island; but do you think it is so pleasant to have a scorching sun always over our heads,

"ings of the restless flood, is agreeably alarmed by
"the gay decorations of the surface. With entertain-
"ment and with wonder, he sees the curling waves,
"here glistering with white, there glowing with pur-
"ple; in one place wearing an azure tincture; in ano-
"ther, glancing a cast of undulating green; in the
"whole, exhibiting a piece of fluid scenery, that may
"vie with yonder pencil tapestries, though wrought
"in the loom, and tinged with the dyes of heaven.

"But, while I am transported by fancy to the shores
"of the ocean, the great luminary is sunk beneath the
"horizon, and totally disappears. The whole face of
"the ground is overspread with shades; or with what
"one of the finest painters of nature calls, a dun ob-
"scurity. Only a few very superior eminencies are
"tippt with streaming silver. The tops of groves, and
"lofty towers, catch the last smiles of day; are still
"irradiated by the departing beams. But oh! how
"transient is the distinction! how momentary the gift!
"like all the blessings, which mortals enjoy below, it is
"gone, almost as soon as granted. See! how lan-
"guishingly it trembles on the leafy spire; and glim-
"mers with a dying faintness on the mountain's brow.
"The little vivacity that remains, decays every mo-
"ment. It can no longer hold it's station. While I
"speak, it expires; and resigns the world to the gra-
"dual approaches of night.

Now

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heads, where the days are fifteen times as long as ours, and not the least cloud to moderate its heat? Though I fancy it is for this reason that nature has made great cavities in the moon, we can discern them easily with our telescopes; for they are not seas, but so many caverns or vaults in the middle of a plain; and how can we tell but

Now Twilight grey,
Has in her sober liv'ry all things clad. MILTON.

" Since the sun is departed, from whence can it proceed that I am not involved in pitchy darkness? " Whence, those remainders of diminished brightness? " which, though scarcely forming a refulgence, yet " smooth the rugged brow of night. I see not the " shining orb, and yet am cheered with a portion of his " softened splendor.

" Does he remember us in his progress through other " climes; and send a detachment of his rays to escort " us, in our further motions; or cover (if I may use " the military term) our retreat from the scene of action? " Has he bequeathed us a dividend of his beams, " sufficient to render our circumstances easy, and our " situation agreeable? Till sleep pours it's soft oppressi- " on on the organs of sense; till it suspends all the " operations of our hands; and intirely supersedes any " more occasion for this light.

" The gracious author of our being, has so disposed " the collection of circumambient air, as to make it " productive of this fine and beneficial effect. The " sun-beams falling on the higher parts of the aerial " fluid, instead of passing on in strait lines, are bent " inward and reflected to our sight. Their natural " course is over-ruled, and they are bid to wheel about; " on purpose to favour us with a welcome and salutary " visit. By which means, the blessings of light, and " the season of business, are considerably prolonged. " And what is a very indearing circumstance, prolong-
" ed.

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but (6) the inhabitants of the moon, being continually broiled by the excessive heat of the sun, retire into those great caverns; perhaps, they live no where else, and it is there they build them cities; for we still see in the ruins of old Rome, that part of the city which was under ground, was almost as large as that which was above. We need but take that part away, and the rest would remain like one of these lunar towns; the whole people reside in wells, and from one well to another there are subterraneous passages for the communication of the inhabitants. I perceive,

“ed most considerably; when the vehement heats of
“summer, incline the student to postpone his walk, till
“the temperate evening prevails.

“The darkness comes not, with a blunt and abrupt
“incivility, but makes gentle and respectful advances.
“A precipitate transition from the splendors of day, to
“all the horrors of midnight, would be both inconvenient and frightful. It would bewilder the traveller in his journey; it would strike the creation with amazement; and perhaps, be pernicious to the organs of sight. Therefore, the gloom rushes not upon us instantaneously, but increases by slow degrees; and sending twilight before as its harbinger, decently advertises us of its approach. By this means, we are neither alarmed nor incommoded, by the change; but are able to take all suitable and timely measures for its reception. Thus, says the author, graciously has providence regulated, not only the grand vicissitudes of the seasons, but also, the common interchanges of light and darkness, with an apparent reference to our comfort.”

(6) *The inhabitants of the moon retire into these great caverns.*] Whoever observes the face of the moon with a good telescope, will discern it distinguished with
an

PLURALITY of WORLDS. 87

ceive, madam, you laugh at my reveries, and you are welcome ; but to be free with your ladyship, the ridicule turns more against you than me : for you believe the people in the moon must live upon the surface of their planet, because we do so upon ours, but the contrary is evident ; for as we dwell upon the superficies of our planet, they may not dwell upon the superficies of theirs ; if things differ so much in this world, what must they do in another ? All things

an admirable variety of spots, some like rocks of diamonds, of a very bright lustre, strongly reflecting the sun's light. Other parts look dark ; these have been supposed to be seas, lakes, and fens ; but, with good glasses, they appear to be great caverns and empty pits, whose shadows fall within them, which can never be in a sea or liquid body : and within these dark spots, we observe some bodies of a brighter light, wherewith they out-shine the rest. There seem to be no clouds or vapours in the moon, from whence rain may be generated ; for such clouds would sometimes cover the face of the moon, and hide some of its regions from our sight, which we never observe them to do. But in the moon there is a constant serenity, without any dark weather ; and when there are no clouds in our air, the moon constantly appears with the same lustre. If the moon has an atmosphere, (which is as yet undetermined) it is very thin ; for the planets and stars, which are sometimes seen very near its edge or limb, have not their light refracted, as it is when it passes through our atmosphere.

Astronomers have drawn the face of the moon, according as it is seen with the best telescopes ; for which we are obliged to the labours of Langrenus, Hevelius of Dantzick, Grimaldus, and Ricciolus, Italians ; who have taken care to note all the shining parts of the moon's face, and even to give names to every part. See the foregoing note, p. 54, &c.

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things may be very different there, from what
they are here.

It is no matter, says the lady, I can never
suffer the inhabitants of the moon to live in per-
petual darkness. You will be more concerned for
them, madam, when I tell you that one of the
ancient philosophers long since discovered the
moon to be the residence of blessed souls depart-
ed out of this life, and that all their happiness
consisted (7) in hearing the music of the spheres,
which is made by the motion of the celestial bo-
dies : and that philosopher, pretending to know
exactly all they do there, tells you, that when
the moon is obscured by the shadow of the
earth, they no longer hear the heavenly harmo-
ny, but howl like so many souls in purgatory ;
so that the moon, taking pity on them, makes
all the haste she can to get into the light again.

Methinks

(7) *In hearing the music of the spheres.*] This kind
of music is spoken of by many of the philosophers
and fathers, supposed to be produced by the regular,
sweetly tuned motion of the stars and planets. Plato,
Philo Judeus, S. Augustine, S. Ambrose, S. Isidore,
Boethius, and many others, are strongly possessed with
the opinion of this music, which they attribute to the
various proportionate impressions of the heavenly bo-
dies upon one another, which acting under proper in-
tervals, form an harmony. It is impossible, say they,
that such spacious bodies, moving with so much rapidi-
ty, should be silent ; on the contrary, the atmosphere,
continually impelled by them, must yield a set of sounds,
proportionate to the impulsions it receives ; consequent-
ly, as they do not all run the same circuit, nor with one
and the same velocity, the different tones arising from
the.

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Methinks then, says the marchioness, we should now and then see some of these blessed souls arrive here from the moon; for certainly they are sent to us; and between the two planets, some think, there is a sufficient provision made for the felicity of souls, by their transportation into a new world. I confess indeed, says I, it would be very pleasant to see new worlds; such a voyage, though but in imagination, is very delightful; but what would it be in reality? It would be much better certainly than to go to Japan, which, at best, is but crawling from one end of the globe to the other, and, after all, to see nothing but men. Well then, says she, let us travel over the planets as fast as we can; what should hinder us? Let us place ourselves at all the different points of view, and from thence consider the

the diversity of motions, directed by the first cause, form an admirable symphony or concert. S. Ireneus, St. Basil, and S. Epiphanius, have controverted this notion, in itself sufficiently chimerical. Yet Milton, in his hymn to the creator, *Paradise Lost*, Book V. alludes to it.

And ye five other wand'ring fires that move
In mystic dance, not without song resound.

And Shakespear, speaks of it more fully in his *Merchant of Venice*, Act V.

Look how the floor of heaven
Is thick inlaid with patterns of bright gold:
There's not the smallest orb that thou beholdest,
But in his motion, like an angel sings,
Still quiring to the young-eyed cherubim,
Such harmony is in immortal souls!
But while this muddy vesture of decay,
Doth grossly close us in we cannot hear it.

the universe. But first, have we any more to see in the moon? Yes, madam, replied I, our description of that world is not entirely exhausted; you cannot but remember that the two movements, which turn the moon on herself and about us, being equal, the one always presents to our eyes that part, of which the other must consequently deprive us; and so she always to us wears the same face: we have then but one half of her which looks on us; and as the moon must be supposed not to turn on her own centre, in respect to us, that half which sees us always, and that which never sees us, remains fixed in the same point of the firmament. When it is night with her, and her nights are equal to fifteen of our days, she at first sees but a little corner of the earth enlightened, after that a larger spot, and so almost by hourly gradations, spreads her light till it covers the whole face of the globe; whereas these same changes do not appear to us to affect the moon, but from one night to another, because we lose her a long time out of our sight. I would give any thing that I could possibly fathom the awkward reasonings of the philosophers of their world, upon our earth's appearing immoveable to them, when all the other celestial bodies rise and set over their heads, within the compass of fifteen days. It is probable they attribute this immobility to her bulk, for she is sixty times larger than the moon; and when their poets have a mind to extol indolent princes, I doubt not but they take care to compare their
inactivity

inactivity to this majestic repose of the earth. However, this opinion is attended with one difficulty; they must very sensibly perceive in the moon, that our earth turns upon her own centre. For instance, imagine that Europe, Asia, and America present themselves, one after another, to them in miniature, and in different shapes and figures, almost as we see them upon maps. Now this sight must be a novelty to such travellers, as pass from that half of the moon which never sees us, to that which always does. How cautious would they be of believing the relation of the first travellers, who should speak of it after their return to that great country, to which we are so utterly unknown? Now I fancy, says the marchioness, that they make a sort of pilgrimage from one side of the country to the other, for their discoveries in our world; and that there are certain honours and privileges assigned to such, as have once in their lives had a view of our great planet. At least, replied I, those who have had this view, obtained the privilege of being better lighted, during their nights; the residence in the other half of the moon must of necessity be much less commodious in that respect. But let us continue the journey we proposed to take, madam, from one planet to another; for we have now had a pretty curious survey of the moon.

As we leave the moon, on that side next the sun, we see Venus, which puts me again in mind of my former reasoning about St. Dennis. Venus

turns

turns upon herself, and round the sun, as well as the moon ; they likewise discover by their telescopes, that Venus, like the moon (if I may speak after the same manner) is sometimes new, sometimes full, and sometimes in the wane, according to the different situations she is in, with respect of the earth.

The moon, to all appearance, is inhabited ; why should not Venus be so too ? You are so full of your whys, and your wherefores, says the marchioness, interrupting me, that I fancy you are sending colonies to all the planets. You may be certain, madam, that is my intention, and I see no reason to the contrary ; we find that all the planets are of the same nature, all obscure bodies, which receive no light but from the sun, and then send it to one another ; their motions are the same, so that hitherto they are alike ; and yet, if we are to believe that these vast bodies are not inhabited, I think they were made but to little purpose : why should nature be so partial, as to except only the earth ? But let who will say the contrary, I must believe the planets are peopled as well as the earth. I find, says the lady, from several instances, you are very obstinate in your opinion. It was but some moments since, that the moon was a desert, and you were in no concern at it ; and at this instant, I see you would be in a passion, if any one should presume to say, that all the planets are not as well stocked with inhabitants as the earth. It is true, madam, at the instant you surprised me with your objections, if you had not opposed my argument for the inhabitants

bitants of the planets, I should not only have maintained their existence, but perhaps likewise have treated on their formation. We have our seasons of credulity, and I never believed these things more firmly than at that juncture: and even now, when my senses are somewhat cooler on the matter, I cannot help thinking it would be strange that the earth should be so well peopled, and the other planets not inhabited at all: for do you believe we discover (as I may say) all the inhabitants of the earth? There are as many kinds of invisible, as visible creatures; we see from the elephant down to the pismire, beyond which our sight fails us; and yet counting from that minute creature, there are an infinity of lesser animals, to which the ant is an elephant, which would be imperceptible without the aid of glasses. We see with magnifying glasses, that the least drop of rain-water, vinegar, and all other liquids, are full of little fishes or serpents, which we could never have suspected there; and philosophers believe, that the acid taste of these liquids, proceeds from a sharpness issued through the forked stings of these animals lodged under their tongues. Mix certain things with any one of these liquors, and expose them in the sun, or let them stand and corrupt, they will produce a new species of little animals.

(8) Some even of the most solid bodies, are nothing but an immense swarm of imperceptible insects,

(8) *Some even of the most solid bodies.]* Late discoveries have confirmed this assertion. All the coralls, coral-lines

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insects, who find for their respective motions as
much room and liberty as they require. A mul-
berry-leaf is a little world, inhabited by multi-
tudes of these invisible worms, which, to them,
is a country of vast extent. What mountains,
what abyſſes are there in it? the insects on one
side of this leaf, know no more of their fellow
creatures on the other, than you and I can tell
what they are now doing at the antipodes: does it
not appear therefore more reasonable, that a
great planet should be inhabited? In the hardest
stones, for example, in marble, there are an in-
finity of worms, which fill up the vacuums, and
feed upon the substance of the stone; fancy then
millions of living creatures to subsist many years
on a grain of sand; so that were the moon but
one continued rock, I would sooner allow her to
be gnawed by her inhabitants, than not be inhabited:
in short, all is full of life, every thing is animated;
imagine

lines, madrapores, and many sea productions, are found
to be the nests and work of animals. [See in the philoso-
phical transactions, An. 1755, &c. Mr. Ellis's curious
account of this subject.] And indeed almost every liquid
is, by many of the modern philosophers, found to be re-
plete with living creatures; and experiments made with
microscopes shew, that the leaves of trees, their excres-
cences, and various kinds of fruit, abound with them.

A very celebrated poet, in a beautiful paragraph on
this subject, informs his readers, that all nature swarms
with life. In subterranean cells, the earth heaves with
vital motion. Even the hard stone, in the very inmost
recesses of its impenetrable citadel, holds multitudes of
animated inhabitants. The pulp of mellow fruit, and
all the productions of the orchard, feed the invisible
nations. Each liquid, whether of acid taste, or milder
relish,

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imagine then those animals which are yet undiscovered, and add them and these which are but lately discovered, to what we have always seen, and you will find the earth swarms with inhabitants, and that nature has so liberally furnished it with animals, that she is not at all concerned for our not seeing above one half of them : why then should nature, which is fruitful to an excess here, be so very sterile in the rest of the planets, as to produce no living things in them ? I must own, says the marchioness, you have convinced my reason, but you have confounded my fancy, with such variety, that I cannot imagine how nature, which abhors repetition, should produce so many different kinds. There is no need of fancy, madam, do but trust your eyes, and you will easily perceive how nature diversifies her works in these several worlds.

All

relish, abounds with various forms of sensitive existence. Nor are the pure stream, and transparent air, without their colonies of unseen people. In which constitution of things, we have a wonderful instance, not only of the divine goodness to these minute beings, in giving them a capacity for animal gratifications ; but of his tender care for mankind in making them imperceptible to our senses.

— These concealed

By the kind art of forming heaven escape
The grosser eye of man : for, if the worlds,
In worlds inclosed, should on his senses burst ;
From cates ambrosial, and the nectar'd bowl,
He'd turn abhorrent ; and, in dead of night,
When silence sleeps o'er all be-stunn'd with noise.

Thomson's Summer.

When

All human faces, in general, are of the same model ; and yet the Europeans and the Africans have two particular shapes. nay, commonly every family has a different aspect ; what secret then has nature to shew so much variety in the single face ? Our world, in respect of the universe, is but a little family, wherein the several faces have some resemblance to each other ; in another planet there is another family, whose faces have a different air and make ; the difference too increases with the distance ; for whosoever should see an inhabitant of the moon, and an inhabitant of the earth, would soon perceive they were of different worlds, yet nearer neighbours than one of the earth and one of Saturn : Here, for example, we have the use of speech ; in another world they may

When, says Mr. Hervey, in his *Contemplations on the Starry Heavens*, I stretch my thoughts to the innumerable order of beings which inhabit all those spacious systems, from the loftiest seraph, that surrounds the throne, to the puny nations which tinge with blue the surface of the plum, * or mantle the standing pool with green : O how various are the links in this immense chain ! how vast the gradations in this universal scale of existence ! yet all these, however vast and various, are the work of God's hand, and are full of his presence.

* Ev'n the blue down the purple plum surrounds
A living world, thy failing sight confounds.
To HIM a peopled habitation shews,
Where millions taste the bounty God bestows.

From a Poem, called, DEITY.

Mr. Bradley, in his *Treatise on Gardening*, mentions an insect, which, after accurate examination, he found to be a thousand times less than the least visible grain of sand.

may speak by signs ; and, (9) at a greater distance they may not speak at all : here our reason is formed by experience ; in the next world, experience contributes but little towards reason ; and, in the next to that, old men know no more than children. Here we are more troubled with what is to come than with what is past ; in the next world, they may be more troubled for what is past, than what is to come ; and farther off, they may not be concerned about either, which, by the bye, I think is much better. Here, it is thought, we want a sixth sense, that would teach us many things of which we are now ignorant ; this sixth sense

F

stand ; at the same time declaring, that such an Animalcule, though quite imperceptible to the naked eye, is a bulky being, compared with others, almost infinitely more minute, discovered by Mr. Lewenhoeck.

If then we consider the several limbs which compose (if one may be allowed the expression) such an organized particle ; the different springs which actuate such a set of limbs ; the flow of spirits inexpressibly more attenuated, which put these springs in motion ; the various fluids that circulate ; the different secretions that are performed ; together with a proportionable minuteness of the solids, before they arrive at their full growth ; not to mention other more astonishing modes of diminution ; sure we shall see the utmost occasion to acknowledge, that the adored maker is, *Maximus in minimis* ; greatly glorious, even in his smallest works.

(9) *At a greater distance they may not speak at all.*]
As we may reasonably suppose the inhabitants of the other planets to be rational, so we may justly imagine them to be social beings. If so, our author does not seem to be serious in this article : For as Mr. Harris, in his *Hermes*, says, with regard to us, “ If men by nature had
“ been framed for solitude, they had never felt an
“ impulse

is apparently in another world, where (10) they may want one of the five which we enjoy; nay, perhaps there is a much greater number of senses, but in the partition we have made of them with the inhabitants of the other planets, there are but five fallen to our share, with which we are well contented, for want of being acquainted with the rest. Our sciences have bounds, which the wit of man could never pass; there is a point where they fail us on a sudden; the rest is reserved for other worlds, where somewhat which we know may be unknown to them. This planet enjoys the pleasures of Love, but lies desolated in several places by the fury of war; in another planet they may enjoy perpetual peace, yet in the midst of that peace, may not know any thing of love, and time may lie heavy on their hands; in a word, that which nature practises here in little, in distributing her gifts among mankind, she

“impulse to converse with one another; and if, like
 “lower animals, they had been by nature irrational,
 “they would not have recognized the proper subjects
 “of discourse.”—And “That speech is the joint energy
 “of our best and noblest faculties (that is to say, of our
 “reason and social affection) being withal our peculiar
 “distinction and ornament, as men.” So the planetary
 inhabitants might as well be irrational as have no speech;
 as social beings they could not be, unless they have a
 peculiar method of perception, somewhat like what the
 school-men call intuition, of which we have no idea.

(10) *They may want one of the five.*] With regard to our senses, we may be said to have but one, viz. feeling, all our senses may be reduced to this one, and the other four are only subdivisions of it.

she may practise at large in other worlds, where she makes use of that (11) admirable secret she has to diversify all things, and, at the same time, makes them equal, by compensating for the inequality.

But is it not time, madam, now to be serious, have I given you enough of chimæra? Trouble not yourself, says she; fancy is a great traveller; I already comprehend all these worlds, and form to myself their different characters and customs; some of them, I assure you, are very extraordinary;

(11) *Admirable secret she has to diversify all things.*

Our author's imagination is lively; yet his various changes are, and must necessarily be made according to the idea we have, as derived from sense, that being the origin of our ideas; and the whole is only guess or fancy: for as to the inhabitants of the other worlds, we cannot know any thing of them with certainty, and can only draw conclusions from a chain of reasoning concerning them. Allowing the author's opinion just, as to the various and different perfections the inhabitants of different planets may enjoy, we may carry our imagination a degree farther, and suppose there is a world, or state, where every perfection may be united, and the beings thereof may have attained that ultimate point, to which immortal beings are, by their great Creator, destined to arrive. We would be here understood to mean such a perfection, as reasonable, yet created, beings, may be supposed to enjoy.

Milton thinks, that the inhabitants of the moon are either translated saints, or spirits of a middle nature between angels and Men.

Those argent fields more likely habitants,
Translated saints, or middle spirits hold
Betwixt th' angelical and human kind.

Par. Lost. B. iii. v. 460.

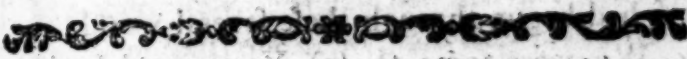
But

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nary ; I see at this moment, a thousand various figures, though I cannot well describe them. Leave them, says I, to your dreams ; we shall know to-morrow whether they represent the matter faithfully, and what they have taught you, in relation to the inhabitants of any of the planets.

But it is greatly to be questioned whether his notion be just ; for as the moon is certainly less considerable in herself than our earth, it is not likely that her inhabitants should be so much more considerable.





The FOURTH EVENING.

Particulars of the worlds of Venus, of Mercury, of Mars, of Jupiter, and of Saturn.

THE dreams of the marchionefs were not very fuccessful; they still represented to her the same objects we are acquainted with here on earth, and I had room to reproach her ladyship, as those people do us at the sight of our regular pictures, who themselves make only wild and grotesque paintings. ‘Well,’ say they, ‘this is only an imitation of men, there is no manner of fancy in it.’ We were therefore forced to conclude ourselves ignorant, (1) what sort of inhabitants all these planets had, and content ourselves

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only

(1) *What sort of inhabitants all these planets had.]* This, says Derham, in his Astro-Theology, is a difficulty not to be resolved without a revelation, or far better instruments than the world hath hitherto been acquainted with. But if the reader should have a mind to amuse himself with probable guesses about the furniture of the planets of our solar system, what countries it is probable are there, what vegetables are produced, what minerals and metals are afforded, what animals live there, what parts, faculties and endowments they have, with much more to the same purpose; he may find a pleasant entertainment enough in the great Mr. Christian Huygens’s Cosmotheoreos, (besides our author) and others that have written on the subject.

only to guess at them, and continue the voyage we had begun through these several worlds.

We were come to (2) Venus, and I told her that planet certainly turned on itself, though no body could tell in what time, and consequently were ignorant how long her day lasted; but her year was composed of eight months, because it is in that time she turns round the sun; and seeing Venus is once and a half larger than the earth, the earth appears (to them in Venus) to be a planet of the same size as she appears to us; the different magnitudes of both being insensible at so great a distance. I am contented, said the marchioness, for the earth to be to Venus the star of the shepherds, and the mother of the loves, as Venus is to us; but these names can only agree to a little planet, which is very brisk, gay, and shining, and which hath a very gallant air. I allow all this, answered I; but do you know what it is that renders Venus so pleasing at that

(2) *We were come to Venus.*] Venus is easily distinguished by her brightness and whiteness, which exceeds that of all the other planets, and which is so considerable, that, in a dusky place, she casts a considerable shadow. Her place, (as is mentioned in a former note, p. 16,) is between the earth and Mercury. She is never seen farther from the sun than 47 degrees, which is little more than a fourth part of the circle he makes above the horizon; when she goes before the sun, that is, rises before him, which she cannot do longer than 3 hours 8 minutes, but at any time less, she is then called Phosphorus, Lucifer, or the morning star; and when she follows him, that is, sets after him, Hesperus, Vesper, or the evening star; and retains the same distance

that distance? It is because she is very frightful at a nearer view. When we see her with the assistance of our telescopes, she appears to be an heap of mountains, much higher than ours, very sharp pointed, and, in appearance, very dry: by this disposition, the surface of a planet is formed, in the most proper manner, for reflecting light, with great splendor and vivacity. Our globe, which, in respect of Venus, is very plain and smooth, and covered over with seas in many parts of it, cannot afford a brilliant appearance at such a distance. So much the worse, replied the lady; for it must certainly be some advantage and pleasure for her to preside over the amours of the inhabitants of Venus; the people there ought to be well versed in gallantry. O doubtless, says I, the very common people of Venus are all

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Celations

distance of time and place after him, as she did before him. She sometimes passes over his limb, and is then seen like a spot in his face, which she will do in June 1761, a phenomenon that rarely happens. Her diameter is 7096 English miles, and is to that of the earth as 10, to 19. Her distance from the sun is 59,000,000 miles, and is $\frac{723}{1800}$ of the earth's distance from him. Her excentricity 5, the inclination of her orbit $3^{\circ} 23'$. Her periodical course round the sun is already mentioned (p. 16.) her motion round her axis, or her day, is performed in 23 hours. Her greatest distance from the earth, according to Cassini, is 38,000 semi-diameters of the earth, and her smallest 6000. Her parallax is 3 minutes; by this her distance from us is discovered. When viewed through a telescope, she is never seen quite round, but gibbous, or horned, like the moon; and her illumined part constantly turned towards the sun,

i. e.

Celadons and Sylvanders, and their most trivial discourses are infinitely finer than any in Clelia. Their very climate inspires love. Venus is much nearer than the earth is to the sun, from whence she receives a more vigorous and active influence and heat. She is situated about two thirds of the distance from the sun to the earth.

I find, says the marchioness, it is easy enough to guess at the inhabitants of Venus; they resemble what I have read of the Moors of Granada, who were a little black people, scorched with the sun, witty, full of fire, very amorous, much inclined to music and poetry, and ever inventing masques and tournaments in honour of their mistresses. Pardon me, madam, says I, you are little acquainted with this planet; Granada in all its glory, was a perfect Greenland to it; and your gallant Moors, in comparison with that people, were as stupid as so many Laplanders.

But

i. e. towards the east when she is the morning star, and towards the west when the evening one. M. De la Hire, in 1700, through a telescope of 16 feet, discovered mountains in Venus, which he found to be higher than those in the moon; and Cassini, and Campani, in 1665 and 1666, discovered spots in her face; from the appearances of which, they ascertained her motion round her axis. In 1672, and 1686, Cassini, with a telescope of 34 feet, thought he saw a satellite moving round this planet; and distant from it, about one fifth of Venus's diameter. It had the same phases as Venus, but without any determinable form; and its diameter scarcely exceeded one fourth of that of Venus. Dr. Gregory thinks it more than probable, that this was a satellite or moon, and supposes the reason why it

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But what do you think then of the inhabitants of Mercury? They are yet nearer to the sun than Venus, and, with respect to us, they are nearer in the proportion of 32 to 81, and are so full of fire, that they are absolutely mad; I fancy they have not any memory at all, no more than most of the Negroes, who make no reflexions; and what they do is by sudden starts, and perfect hap-hazard; in short, Mercury is the bedlam of the universe; the sun appears to them six times greater than it does to us, because they are much nearer to it than we; it sends to them so bright and strong a light, that the most glorious day here, would be no more with them, than a declining twilight: I know not, whether they can distinguish objects; but the heat, to which they are accustomed, is so excessive, that they would be starved with cold in our torrid

F 5

zone;

is not usually seen, to be the unfitness of its surface, to reflect the rays of the sun's light; as is the case of the spots in our moon. For if the moon was intirely smooth, that planet probably could not be seen as far as Venus. The French astronomers have also pretended of late, to have seen this satellite. The inhabitants, if there be such in Venus, never see Mercury in opposition to the sun, no more than we can see Venus in that position, which is occasioned by Mercury's never removing more than 28 degrees, or thereabouts from it. The sun appears to them by half larger in his diameter, and above twice as large in his circumference, as he does to us: and by consequence affords them twice as much light and heat. When our earth is on the other side of the sun from Venus, it appears larger and lighter to her than she does to us, and her inhabitants may

zone; then farther, it is certain, our iron, our gold, our silver, &c. would melt with them, and we should see them only liquid, as we commonly see water here, although when frozen it is a very solid body. The people of Mercury suspect not, that, in another world, those liquids are the hardest bodies we know, though perhaps their rivers are formed of them. Their year is but three months, and we know not the exact length of their day, because (3) Mercury is so little, and so near the sun, it is (as it were) lost in his rays, and is very rarely discovered by the astronomers; so that they cannot observe how it moves on its centre; but because it is so small, they

may also see our moon. She is probably surrounded by an atmosphere so dense, that it is capable of reflecting the sun's light as far as to the earth.

(3) *Mercury is so little, and so near the sun.*] He is the smallest of the primary planets, and as far as we know, the next to the sun, though there may be also others, unknown to us, between him and the sun, which we cannot discover, as they may be lost in the solar rays. His mean distance from the sun is to that of our earth from the sun as 387 to 1000; its eccentricity 8 degrees. The inclination of its orbit, that is, the angle formed by the plane of its orbit to the plane of the ecliptic, is said to be 6 deg. 52 min. Its distance from the sun is 32,000,000 English miles. His periodical time or year, is 87 days, 23 hours, 16 min. His diameter is but 4240 miles, and is to that of the earth as 3 to 4; and therefore his globe is to that of the earth as 2 to 5. According to Sir Isaac Newton, the heat and light of the sun, on the surface of Mercury, is 7 times as intense as on the surface of our earth in the middle of summer; which, as he found by experiments

they fancy it compleats its motion in a little time ; so that by consequence, the day there is very short, and, with regard to its inhabitants, it is necessary that it should finish this tour in a very short time ; for they must be continually wishing for night, as they are actually burning, near a great and ardent fire suspended over their heads : and during their night, Venus and the earth (which must appear considerably large) give light to them. As for the other planets which are beyond the earth, towards the firmament, they appear less to the inhabitants of Mercury, than they do to us here, and they receive but little light from them.

What

periments made for that purpose by a thermometer, is sufficient to make water boil, and set all our dry plants on fire ; consequently what Fontenelle says about melting metals, &c. in that planet is false. However, such a degree of heat, must render Mercury uninhabitable to creatures of our constitution. And if bodies on its surface be not inflamed, and set on fire, it must be, because their degree of density must be proportionably greater, than that of such bodies are with us. The force of gravity on the surface of Mercury, is 7 times as strong as on the surface of the earth ; its density, and consequently the gravitation of bodies towards the centre, cannot be accurately determined ; but no doubt it must exceed that of our earth, by reason of the excess of heat there. Mercury changes its phases like the moon, in regard to its several positions to the sun and earth. It appears full in superior conjunctions with the sun, because we can see the whole illumined hemisphere ; but in its lower conjunction, we only see the obscure or unillumined hemisphere. In his approach towards the sun, his light is falcated or horned.

The

What signifies this, says the lady; I pity them for the excessive heat they endure; let us give them some relief, and send Mercury a few of those cool and refreshing showers, which continue, sometimes, four months together, in the hottest countries, during their greatest extremity. Your fancy is good, madam, replied I, but we will relieve them another way. China is extremely hot by its situation; yet, in July and August so cold, that the rivers are frozen; the reason is, this country produces great quantities of salt-petre, the exhalations proceeding from this salt are very cold, which being raised in great abundance, by the excessive heat of the sun, makes a perfect winter at midsummer. We will fill

The situations of Venus and this planet prove evidently, that the Ptolemaic system is false; for both these planets are observed betwixt the earth and sun, and sometimes beyond the sun; but the earth is never found between them and the sun, which however must happen, if the spheres of all the planets encompassed the earth as a centre, according to that scheme. See Plate II.

In the years 1736, 1743, 1753, and 1756, Mercury was seen like a black spot in the sun; and will be again so seen in 1769, 1776, 1782, and 1789, in October; and in 1786, and 1799, in April, he will pass over the sun's disk, according to Dr. Halley's predictions.

Venus will, in like manner, cross over the sun in 1761, 1769, 1996, 2004, in June each of these years; and in 1874, 2019, 2117, in December; at which times she will appear a black, but beautiful, spot in the sun.

The diameter of the sun, viewed from Mercury, would appear three times as large, as it appears from the earth, the sun being thrice as near him as we are;

and

fill this little planet with salt-petre, and let the sun shine as hot as he pleases, himself shall produce a remedy for the evil he may otherwise cause them. And yet after all, who knows but the inhabitants of Mercury may have no occasion either for rain, or salt-petre? If it is a certain truth, that nature never gives life to any creature, but where that creature may live; then, through custom, and ignorance of a better life, those people may live happily.

After Mercury, comes the sun; but there is no possibility of peopling it, nor any room left for a wherefore. By the earth, which is inhabited, we judge that other bodies of the same nature may be likewise inhabited: but the sun

is

and therefore the sun's disk would appear 7 times as large as it appears to us. As we can never see him more than 28 degrees from the sun, he is very seldom seen by us, being either lost in the sun's light, or, when remotest from the sun, in the twilight. The best time for observing him, is when he is on the sun's disk; for in its lower conjunction it passes by the sun like a spot, eclipsing a small part of him, like a patch upon a lady's face, only observable with a telescope. The first observation of this kind was made by Gassendi in 1632. To an inhabitant of Mercury, the solar spots will appear to traverse his disk, sometimes in a right line from east to west, and sometimes elliptically. As the other five planets are above Mercury, they will appear nearly there as they do with us. Venus and the earth, when in opposition to the sun, will shine on Mercury with full orbs, and afford a glorious light to that planet.

Its inhabitants must have the same opinion of us that we have of Saturn, that we must be intolerably cold; and have little or no light, we are so far from the sun.

is a body not like the earth, or any of the planets; (4) the sun is the source or fountain of light, which, though it is sent from one planet to another, and receives several alterations by the way, yet it all originally proceeds from the sun: they may make, as we may say, exchanges among themselves, but they cannot produce light. He draws from himself that precious substance which he emits with rapidity on all sides, and which reflects when it meets with a solid body, and spreads from one planet to another those long and vast trains of light, which cross, strike through, and intermingle in a thousand different ways,

(4) *The sun is the source or fountain of light.* Boerhaave says, it is probable, that in the action of fire observed among us, the sun does not emit any fiery matter to which such action may be attributed; but that this luminary has only a power of directing the fire, already existing in any place, into parallel right lines, from whence the same quantity of fire being again collected out of its parallelism by reflection or refraction, and united still closer, acquires new powers; and thus is able to produce all its effects. To illustrate this, by an easy experiment; suppose an hollow brass cube, upwards of 3 inches square, and closed every way, except that one side being taken off, it is left open there; and suppose this cube directly opposed by its open side to the sun, only covered with a white paper; in the cavity of it apply Fahrenheit's tender thermometer, which consists of a moveable spirit; while the paper prevents the sun's rays from penetrating the cavity of the cube, if the weather be cold, we shall find an intense cold in the whole vacant space of the cube; take away the paper at once, and at the moment the cavity of the cube is illuminated by the sun, there immediately rises.

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ways, and form (if I may so say) the richest tissues in the world. The sun is placed in the centre, from whence, with most convenience, he may equally distribute his light, and animate the whole planetary world by his heat; it is then a particular body, but what kind of body, has often puzzled better heads than mine. It was thought formerly to be a body of pure fire, and that opinion passed current till the beginning of this age; when astronomers perceived several spots on its surface. A little after this they discovered new planets, (which we shall presently hear

rises a considerable heat, indicated by the thermometer. It may be said, that this heat was sent with an inconceivable velocity from the sun's body: to me (says he) it rather appears, that the sun has only done now what it did before, and which it always does, *viz.* determine what we call fire, into right lines, which can now reach the opaque body without any obstacle, and thus drives the fire, which before, while the paper interposed, was equally diffused through the six containing squares; drives it, we may say, without altering its quantity in right lines against one side opposite to the open one, and thus heats the whole cavity, but especially such side by merely directing the rays, and not by any increase of their number. This opinion of fire, that it is originally such, formed by the creator himself at the beginning of all things, and not producible by any motion or alteration of other bodies; and that neither the fire produced by the collision of a flint and steel, nor by a burning glass, appears to owe any thing of its matter to the sun, is maintained by Homberg, Boerhaave, the younger Lemery, Gravefande, &c. But Sir Isaac Newton, and after him most of the English writers, assert, that it is mechanically producible from other bodies, by inducing some alteration in the particles thereof; and

hear of) (5) these spots some philosophers called planets; for those planets moving over the sun, when they turned their dark half to us, must necessarily hide part of it; the learned with these pretended planets made their court to most of the princes in Europe, giving the name of this prince to one, and of that prince to another planet. I believe they would have quarrelled who should be master of these spots, that they might have named them as they pleased, had it not been otherwise determined.

I cannot approve their notion; it was but the other day, says she, you were describing the moon, and called several places by the names of the most famous astronomers. I was pleased with the fancy; for since the princes have seized

and that fire is such merely by motion, and not existing from the beginning. His opinion that the sun is a body of fire, may be seen in the next note but one.

(5) *These spots some philosophers called planets.*] The spots in the sun are only visible through a telescope: some distinguish them into maculæ or dark spots, and faculæ or bright ones, but there seems little foundation for this division. These spots are very changeable, as to number, form, &c. they are sometimes in a multitude, and at other times, none are to be seen. Some fear, that they may become so numerous as to hide the sun's face, at least the greatest part of it; and to this ascribe what Plutarch tells us, viz. that in the first year of the reign of Augustus, the sun's light was so faint and obscure, that one might look steadily at it with the naked eye. To which Kepler adds, that in 1547, the sun appeared reddish, as when viewed through a thick mist; and hence he conjectures that the solar spots:

ed on the earth, it is fit the philosophers (who are as proud as the best of them) should reserve the heavens for themselves, without any competitors. O, answered I, trouble not yourself, the philosophers make the best advantage of their territories, and if they part with the least star, or a part of the moon, it is upon very good terms; but the spots on the sun are fallen to nothing; it is now discovered, that they are not planets, but clouds, steams, or dross which rises upon the sun, sometimes in a great quantity, sometimes in a less; sometimes they are dark, some-

spots are only a kind of dark clouds or smoke, floating on its surface. It is therefore probable, they are opaque bodies, in manner of crusts, formed like the scums on the surface of liquors.

However, these spots demonstrate the sun's motion round his axis, like that of the earth, whereby the natural day is measured, only slower. Some of these spots have made their first appearance near the edge or margin of the sun, and have been seen sometime after on the opposite edge; whence, after a stay of about fourteen days, they have re-appeared in their first place, and taken their same course again, finishing their intire circuit in twenty seven days time; which is hence deduced to be the period of the sun's rotation round its axis. This motion of the spots is from west to east; whence we conclude, that of the sun to which the other is owing, to be from east to west. Sometimes these spots stay three days longer behind the sun, than they spend in passing over this side of it; consequently that they do not adhere to the surface of the sun, but are at some distance therefrom. This gave rise to the conjecture of their being planets that revolved round it. But as they frequently are seen to rise and vanish, even in the midst of the sun's face, and undergo several changes

sometimes clear; sometimes they continue a great while, and sometimes they disappear as long. It seems the sun is a liquid matter, some think of melted gold, which appears to boil over continually, and by the force of its motion, casts the scum or dross on its surface, where it is consumed, and more arises. Imagine then, what vast bodies these are, when some of them are seventeen hundred times as large as the earth, which is more than a million of times less

changes, both in regard to figure, bulk, and density; it follows, that they frequently rise, from the sun's interior part, and are again dissipated. Hence they are not planets, but are formed from the sun's body; and as they arise to a certain height, it is evident there is some fluid encompassing the sun, to urge them to ascend; and this fluid must be thicker or denser at bottom, and rarer at top, like our atmosphere. Since they frequently are seen to disappear in the middle of the sun's face or disk, they fall back again into the sun. As their revolution is regular, it shews, as they are at some distance from it, that they do not move round the sun, but are carried with it in his atmosphere and with himself. That their distance is not great from the sun, is proved from their being seen near half the time of their period on the face of the sun; for if their distance was considerable, the time in passing over the sun's body, would be very small in proportion to the remaining time taken up in their rotation round him. After Galileo, Schenkerus observed these spots more accurately, and published a large volume about them; when he observed them, there were visible in the body of the sun no less than fifty of these spots. From the year 1650 to 1670, there were rarely seen above one or two together; but many have been observed since that time. However, there does not seem to be any period of time, or law for their appearing, or dissolution.

Milton

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less than the sun. Judge by this, what a vast quantity must there be of this melted gold, and what must be the extent of (6) this great sea of light and fire which they call the sun? Others say, and with great appearance of reason, that the spots, or, at least, the greater part of them, are not new productions, that dissipate themselves at the end of a certain time; but great solid masses, of very irregular figures, that always exist, which sometimes float upon the liquid body of the sun; at other times bury themselves intirely, or in part, and present to us different points or eminences, according as they are more or less plunged in the liquid substance of the

Milton makes the Devil, in his vagabond flight through our system, light on the sun, and compares him to a spot on his surface

There lands the Fiend, a spot like which perhaps
Astronomer in the Sun's lucid orb,

Thro' his glaz'd optic tube, yet never saw.

The sun, though commonly supposed to be at rest in the centre of the solar system, has besides its motion round its axis, also a second motion round a certain point, which is the true or common centre of all the planetary motions; and this point is at most not quite a diameter of the sun distant from its centre. About this point the sun therefore moves, but in what time is uncertain.

Though the sun appears round or spherical, it is really spheroidical, higher under its equator than about the poles, that is, its diameter, drawn through the equator, is greater than that drawn through the poles.

(6) *This great sea of light and fire which they call the sun.* In the last note but one, we have given Boerhaave's doctrine of the sun, that it does not emit any

the sun; and that they turn towards us different sides. Perhaps, they make part of some great solid mass of matter, which serves as aliment to the fire of the sun. But let the sun be what it will, it cannot be at all proper for habitation; and what pity that is; for how pleasant would it be? You might then be at the centre of the universe, where you would see all the planets turn regularly about you; but now we are only possessed with extravagant fancies, because we do not stand in the proper place; there is but one place in the world where the study or knowledge of the stars may be easily obtained, and what pity it is there is no body there. You forget yourself sure says she, were you in the sun, you would see nothing, neither planets nor fixed stars; does not the sun efface all? So that could there be any

any fiery matter. But the English philosophers, after Sir Isaac Newton, assert, that the substance of the sun is fire, which they thus endeavour to prove. He shines, and his rays, collected by concave mirrors, or convex lens's, burn, consume, and melt the most solid bodies, or else convert them into ashes, or glass. Wherefore, as the force of the solar rays is diminished by their divergency, in a duplicate ratio of the distances reciprocally taken; it is evident their force and effect is the same, when collected by a burning lens or mirror, as if we were at such distance from the sun, where they were equally dense. The sun's rays, therefore, in the neighbourhood of the sun, produce the same effects as might be expected from the most vehement fire; consequently the sun is of a fiery substance. Hence it follows, that his substance is every where fluid, that being the condition of flame. But whether the whole body

any inhabitants there, they might justly think themselves the only people in nature.

I own my mistake, madam; I was thinking of the situation of the sun, and not of the effect of its light: I thank you for your correction; but must take the freedom to tell you, that you are also in an error; for were there inhabitants in the sun, they would not see at all, either they could not bear the strength of its light, or for want of a due distance, they could not receive it; so that things well considered, all the people there must be stone blind; which is another reason why the sun cannot be inhabited: but let us pursue our voyage through the other worlds. We are now arrived at the centre, which is always the bottom, or lowest place of what is round; if we go on, we must travel thirty-three millions of leagues, we must return the same way we came, and ascend; then we shall find Mercury, Venus, the earth, the moon, all these planets

body of the sun be fluid as some think, or solid as others, is not determined: yet as there are no marks to distinguish fire from other bodies, but light, heat, a power of burning, consuming, melting, calcining, and vitrifying; it is difficult to conceive the sun to be any thing but a globe of fire invested with flame. That he is that great sea of light, from whence all the planets draw theirs, is universally acknowledged; which truth is thus justly, as well as poetically, described by Milton.

Hither, as to their fountain other stars
Repairing, in their golden urns draw light.

Par. Lost, B. VII. l. 364.

nets, we have already visited; (7) the next is Mars, who affords nothing curious that I know of; his day is rather more than half an hour longer than ours, but his year is twice as long, wanting about a month and near an half. He

ii

(7) *The next is Mars.*] Fontenelle hurries over this planet, as he could not draw much from him, relative to his subject. However, the curious reader will undoubtedly be pleased to be informed of such particulars, as are worthy his regard, concerning this planet. His situation is between the earth and Jupiter; his mean distance from the sun is 1524 of these parts, whereof the distance of the earth from the sun is 1000, or more accurately 123,000,000 English miles. Its eccentricity 141; the angle formed by the plane of its orbit, to the plane of the ecliptic, or the inclination of its orbit, 1 deg. 52 min. The periodical time in which he revolves round the sun, is 686 days, 23 hours. Its day is much the same length as ours; for he revolves on his own axis in 24 hours, and 40 minutes. Its diameter is 4444 English miles. According to Hook and Flamsteed, its parallax is scarce 30 seconds. When he is in opposition to the sun, he is found then to be twice as near the earth as the sun; which is a phenomenon that hath also discredited the Ptolemaic system. In 1665, Dr. Hook observed several spots in Mars, which having a motion, he concluded him to turn round his centre. M. Cassini observed several spots in the two faces or hemispheres of Mars, which, by continuing his observations very diligently, he found to move, by degrees, from east to west; and to return in 24 hours, 40 min. to their former station. He always appears reddish, and with a troubled light; whence, it is concluded to be encompassed with a thick cloudy atmosphere; which, by disturbing the sun's rays in their passage and re-passage through it, occasions that appearance. In revolving round the sun, it has its increase and decrease like the moon; it may be observed almost divided into

two

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is about four times less than the earth, and the sun seems not altogether so large and so bright to him, as it appears to us. But let us leave Mars, he is not worthy our stay: but what an agreeable

two by the light and dark sides; but is never horned as Venus, Mercury, and the moon are. As his distance from the sun, is to the distance from the earth and sun as $1\frac{1}{2}$ to 1, a spectator placed in him would see the sun's diameter less by $\frac{1}{3}$ than it appears to us; and consequently, the degree of light and heat which Mars receives from the sun, is less by $\frac{1}{3}$ than that received by the earth. This proportion, however, will admit of a sensible variation on account of the great eccentricity of this planet, i. e. his moving in an oval, not in a circular orbit. Though his year be twice as long as ours, and his day is almost in all parts of him equal to his night, yet it appears, that in one and the same place on his surface, there will be but very little variety of seasons; scarce any difference of summer and winter. And the reason is, that the axis of his daily rotation is nearly at right angles with the plane of his orbit. It will be found notwithstanding, that places situated in different latitudes, that is, at different distances from the equator, will have very different degrees of heat, on account of the different inclination of the sun's rays to the horizon, as it is with us, when the sun is in the equinoxes. From this consideration, Dr. Gregory endeavours to account for the appearance of the fasciæ, which are certain swatches or belts seen in this planet, and placed parallel to his equator: for, among us, the same climate has, at different seasons, very different degrees of heat; but in Mars it is not so, the same parallel having always a pretty equable degree of heat: it follows, that these belts may be formed in his atmosphere, as snow and clouds are in ours, viz. by the constant different intensities of heat and cold in the different parallels; and so may to be extended in circles or belts parallel to his equator.

greeable object is (8) Jupiter with his four moons, or satellites? They are four little planets which turn round him, whilst Jupiter revolves round the sun in twelve years, as our moon turns round

us.

æquator, or the circle of his diurnal revolution. And this same principle may perhaps solve the cause of the same appearance on the body of Jupiter also, that planet, like Mars, having a perpetual equinox.

Besides his red colour, there is another argument of his being encompassed with an atmosphere, and it is this; that when any fixed star is seen near his body, it appears much obscured, and almost extinct. This dense atmosphere must prevent a spectator, placed in Mars, from ever seeing Mercury, unless, perhaps, in the sun, at the time of conjunction, when Mercury passes over his disk. A spectator in Mars will see Venus about the same distance from the sun, as Mercury appears to us; and the earth about the same distance from the sun, that Venus appears to us. And when the earth is found in conjunction with and very near the sun, he will see from Mars, what Cassini observed from the earth of that planet, *viz.* the earth horned or falcated, and its attendant the moon of the same figure; and her utmost distance from the earth not above 15 minutes of a degree. He is less than Venus, nor has he a moon to attend him; and in that he is our inferior, as well as Mercury and Venus.

However, he appears at different times of very different magnitudes, being observed sometimes to be almost as large as Jupiter; and at others so small, as not to be distinguished from a fixed star, but by his motion and red colour. These various changes are owing to his different distances from the earth, which are very considerable.

(8) *Jupiter, with his four moons.*] Jupiter is the largest of all the planets, nay larger than all the others put together, his diameter being 8155 English miles, which is to that of the sun, as appears by astronomical observations, as 1077 is to 10000; to that of Saturn,

us. But why, says the marchioness, interrupting me, must there be planets to turn round
 G other

as 1077 to 889; to that of the earth, as 1077 to 104. The force of gravity on his surface is to that on the surface of the sun, as 797,15 is to 10,000; to that of Saturn, as 797 is to 534,337; to that of the earth, as 797,15 to 407,832. The density of its matter is to that of the sun, as 7404 to 10,000; to that of Saturn, as 7404 to 6011; to that of the earth, as 7404 to 3921. The quantity of matter contained in his body, is to that of the sun, as 9,248 to 10,000; to that of Saturn, as 9,248 to 4,223; to that of the earth, as 9,248 to 0,0044. The mean distance of Jupiter from the sun is 5201 of those parts whereof the mean distance of the earth is 1000; that is, he is 424,000,000 English miles from the sun. Kepler makes him not more than 5196 of those parts. M. Cassini calculates Jupiter's mean distance from the earth to be 115,000 semi-diameters of the earth. Gregory computes the distance of Jupiter from the sun to be above five times as great as that of the earth from the sun; whence he gathers, that the diameter of the sun to an eye placed in Jupiter, would not be a fifth part of what it appears to us; and therefore his disk would be twenty-five times less, and his light and heat in proportion.

Jupiter is situated between Mars and Saturn; he revolves round his axis in 9 hours, 56 min. and his periodical revolution round the sun is in 4332 days, 12 hours, 20 min. 9 seconds. The inclination of his orbit, that is the angle formed by his orbit to the plane of the ecliptic, is 1 deg. 20 min. His eccentricity is 250; and Huygens computes his surface to be 400 times larger than that of the earth. His distance from us is so great, that it has no sensible proportion to the diameter of the earth. Hence this planet has no parallax.

Though it be the greatest of the planets, yet its revolution about its axis is the swiftest; its polar axis is observed to be shorter than its æquatorial diameter; and
 Sir

other planets, that are no better than themselves? I should think it would be more regular and uniform,

Sir Isaac Newton determines the difference to be as 8 to 9; so that its figure is a spheroid, and the swiftness of its rotation occasions this figure to be more sensible than in any other of the planets.

Jupiter appears almost as large as Venus, but is not altogether so bright: he is eclipsed by the moon, by the sun, and even by Mars. Hevelius once, as it is said, observed Jupiter's diameter as large as 7 inches, and that it had inequalities like the moon. He has three appendages like zones, or belts, which Sir Isaac thinks are formed in his atmosphere. In these are several spots, from whose motion, that of Jupiter round his axis is said to be determined. The discovery of which is controverted between Eustachio, P. Gotignies, Cassini, and Campani. See Plate IV. fig. 3.

The day and night in Jupiter are of the same length all over his surface; *viz.* five hours each; the axis of his diurnal rotation being nearly at right angles to the plane of his annual orbit. Though there be four primary planets below Jupiter, yet an eye placed on his surface, would never perceive any of them; unless, perhaps, as spots passing over the sun's disk, when they happen to come between the eye and the sun. The parallax of the sun, viewed from Jupiter, will scarce be sensible, no more than that of Saturn, neither being much above 20 seconds; so that the sun's apparent diameter in Jupiter, will not be above 6 minutes. His outermost satellite will appear almost as big as the moon does to us, *viz.* five times the diameter, and twenty-five times the disk of the sun. Dr. Gregory adds, that an astronomer in Jupiter would easily distinguish two kinds of planets, four nearer him, *viz.* the satellites; and two, *viz.* the sun and Saturn, more remote. The satellites, however, will fall vastly short of the sun in brightness, notwithstanding the great disproportions of the distances and apparent magnitudes. From these four different moons, the inhabitants of Jupiter will have
four

uniform, that all the planets, small and great, without any distinction, should have one and the same motion round the sun.

G 2 Ah,

four different kinds of months, and the number of lunations in their year will not be less than 4,500. These moons will appear eclipsed in Jupiter, as often as, being in opposition to the sun, they fall within the shadow of Jupiter; and again, as often as being in conjunction with the sun, they project their shadows to Jupiter, they make an eclipse of the sun, to an eye placed in Jupiter, where the shadow falls.

But in regard their orbits are in a plane, which is inclined to, or make an angle with the plane of Jupiter's orbit, their eclipses become central, when the sun is in one of the nodes of these satellites; and when out of this position, the eclipses may be total, though not central, because the breadth of Jupiter's shadow, is nearly double to that of the breadth of any of the satellites; and the apparent diameter of any of these moons, is nearly five times that of the apparent diameter of the sun. It is owing to this remarkable inequality of diameters, and the small inclination the plane of the orbits of the satellites has to the plane of Jupiter's orbit, that in each revolution there happen eclipses both of the satellites and the sun; though the sun be at a considerable distance from the nodes. Further, the inferior among the satellites, even when the sun is at its greatest distance from the nodes, will occasionally eclipse and be eclipsed by the sun, to an inhabitant of Jupiter; though the remotest of them, in this case, escapes falling into Jupiter's shadow, and Jupiter into his, for two years together. To this it may be added, that one of these satellites sometimes eclipses another, where the phasis must be different, nay frequently opposite to that of the satellite falling into the body of Jupiter just mentioned; for in this the eastern limb immerses first, and the western limb immerses last; but in the others it is just the reverse. The shadow of Jupiter, though it reaches beyond his satellites, yet falls short of any other planet; nor could any other planet, Saturn alone excepted,

Ah, madam, says I, (9) if you did but know what Descartes's whirlpools or vortexes were (whose name is so terrible, but their idea so pleasant) you would not be of that opinion. Why, says she, smiling, must my head turn round to comprehend them? It must be pleasant to know what these vortexes are: Compleat my folly, I can no longer forbear, nor do I know when or where to stop, as philosophy is the subject. Well, let the world say what it will, go on with your whirlpools. I will, says I, and you shall find that they are worthy of the transports. What we call a whirlpool, or vortex, is a mass of matter, whose parts are separated, or detached from one another; yet they all have one uniform motion; and, at the same time, every particle is allowed to have a particular motion of its own,

pro-

cepted, be immersed in it, even though it were infinite. Indeed Jupiter's shadow could not reach Saturn, unless Jupiter's diameter were half that of the sun; whereas in fact it is not one ninth of it. If there were any such thing as navigation on the globe of Jupiter, the courses of his satellites would render it very sure and easy, as they would constantly give the longitude. Even we, at this immense distance, can make a very good use of them; those eclipses being found one of the best means for determining the longitude at sea. Further particulars relative to these moons, as they appear from our globe, will be given in a succeeding note. If we reason from the analogy of things, the inhabitants of Jupiter exceed ours in stature as much as his globe exceeds ours in bulk. If so, they are at least sixty feet high.

(9) *If you did but know what Descartes's whirlpools or vortexes were.* Concerning these vortices, some account

provided it follows the general direction: thus a vortex of wind, or a whirlwind, is an infinity of little particles of air, which turn round all together, and bear away whatever they meet with. You know the planets are borne up by the celestial matter, which is very subtle and active; so that this great mass, or ocean of celestial matter, which flows as far as from the sun to the fixed stars, turns round, and bears the planets also with it, making them all turn after the same manner round the sun, who possesses the centre; but in a longer, or a shorter time, according as they are at a farther or nearer distance to it: there is not any planet, not even the sun himself, but what turns round its axis: and this the sun performs, because he is just in the middle of this celestial matter; and were the earth in his place, it must turn on itself, as the sun does. This is the great vortex, of which the sun is lord; yet, at the same time, the planets make little peculiar vortexes, in imitation

G 3

of

count has been already given in the preceding notes, page 14 and 29. An artificial vortex may be made, by turning a stick briskly, in a cylindrical vessel, filled nearly with water, which is put into a pretty rapid circular motion, and rises to the edge of the vessel; and when there arrived, ceases to be further agitated. This water forms an hollow in the middle, which is caused by its centrifugal force; for the motion of the water being circular, it respects a centre taken in the axis of the vessel, or that of the vortex. The same velocity being impressed on all the water, a circle less remote from the axis, has a greater centrifugal force, than another which is great-

cr

of that of the sun; each of them in turning round the sun, does, at the same time, turn round itself, and makes a certain quantity of celestial matter turn round it likewise, which is always prepared to follow the particular motion which the planet gives it, provided it is not diverted from its general motion; this then is the particular vortex of the planet, which pushes it as far as the strength of its motion reaches: and if by chance a lesser planet falls into the vortex of a greater planet, it is immediately borne away by the greater, and is indispensably forced to turn round it, though, at the same time, the great planet, the little planet, and the vortex which encloses them, all turn round the sun: it was thus at the beginning of the world, when we compelled the moon to turn round us, because she was then within the sphere of our vortex, and therefore wholly at our disposal. Jupiter

was
 er or more remote from the axis. The smaller drives the greater towards the sides of the vessel; and from this impulse, which all the circles receive from the smaller ones that precede them, and convey to the greater ones that follow them, arises that elevation of the water along the sides of the vessel to the top, where we suppose the motion to cease. Our reason for mentioning this experiment, is to inform the reader, that one M. Saumon in France, made divers experiments of this sort, with artificial vortices, by putting several bodies therein, to acquire a similar circular motion, with intent to discover which of them, in making their several revolutions round the axis of the vortex, approached towards or receded from it, and with what velocity. The result was, that still the heavier the body, the great-
 er

was stronger, or more fortunate than we; he had four little planets in his neighbourhood, and he brought them all four under his subjection; and no doubt, we, though a principal planet, would have shared the same fate, had we been within the sphere of his activity; he is a thousand times larger than the earth, and would certainly have swallowed us into his vortex; we had then been no more than a moon among his attendants, but now we have one to wait on us; so that you see the advantage of situation, often decides all our good fortune.

But pray, says she, who can assure us we shall continue as we do now? If we should be such fools as to go near Jupiter, or he so ambitious as to approach us, what will become of us? For if (as you say) the celestial matter is continually under this great motion, it must needs agitate

G 4 the

er was its recess from the axis. His view was, to shew how the laws of mechanics produce the celestial motions; and that it is probably to those motions that the gravity of bodies is owing. But unhappily, the experiments shew just the contrary of what they were intended, *viz.* to confirm the Cartesian doctrine of gravity; and this he acknowledged to the French royal academy, of which he was a member.

In fact, a dense fluid can serve for no purpose in the heavens but to disturb the motions of the planets, and make the frame of nature languish: if the heavens were filled with a fluid, how subtil soever, without any vacuum, the resistance would be considerable. A solid globe, in such a fluid, would lose above half its motion, while it moved thrice the length of its own diameter; and a globe, not perfectly solid, such as the planets, would lose more. See the system, or vortexes of Descartes, represented Plate II. fig. 3.

the planets irregularly ; sometimes make them approach each other, and at other times make them recede farther. Luck is all, we may win as well as lose, says I ; and who knows, but we might bring Mercury and Mars under our government ; they are little planets, and cannot resist us ; but, in this particular, madam, we need neither hope, nor fear ; for the planets keep within their own bounds, and are obliged, as the kings of China were formerly, not to undertake new conquests. Have you not seen, when you put water and oil together, the oil swims a-top ; and if to these two liquors you add a body extremely light, (as rectified spirit) the oil bears it up, and it will not sink to the water : put an heavier liquor, of a just weight, and it will pass through the oil, which is too weak to sustain it, and sink till it comes to the water, which is strong enough to bear it up ; so that in this liquid, composed of two liquors, which do not mingle, two bodies of unequal weight, will naturally assume two different places ; the one will never ascend, the other will never descend ; if we put still other liquors, which do not mingle, and throw other bodies on them, it will be the same thing : fancy then that the celestial matter which fills this great vortex, has several parts or places, one by another, whose weights or gravity are different, like that of oil, water, and other liquors ; the planets too are of a different weight, and consequently every planet settles in that part of the celestial matter, which has a just strength

to sustain and keep it in a proper equilibrium; so, you see it is impossible it should ever go beyond its true sphere.

I very well apprehend, says the marchioness, that these different gravities keep their stations regularly. Would to God, our world were as well regulated, and every one among us knew their proper place. I am not now in any fear of being over-run by Jupiter; and since he lets us alone in our vortex, with our moon, I do not envy him the four which he has. If you envied him, replied I, you would do him wrong; for he has no more than what he has occasion for. He is removed from the sun five times farther than we are; he is one hundred and sixty five millions of leagues distant, consequently his moons receive, and send him, but a very weak light; their number supplies the little effect of each. It is true, that as he turns upon himself in ten hours, his nights, by consequence, are but five hours long; so one would think there is no great occasion for four moons. The moon which, in regard to Jupiter, is nearest to him, finishes its course about him in forty-two hours; the second in three days and an half; the third in seven; and the fourth in seventeen; and by the inequality of their motions, they all contribute to give him the most agreeable prospects; for sometimes they rise all four together, and then separate according to the inequality of their courses; sometimes they are all in the meridian, ranged one above another; sometimes you see them all four

at equal distances in the heavens ; sometimes when two rise, the other two go down. Oh, how I should like to see (10) their perpetual play of eclipses ; for there is not a day passes, but they eclipse the sun, or one another ; and they are so accustomed to these eclipses in that planet, that they are certainly objects of diversion, and not of fear, as with us.

Well, says the marchioness, I hope you will people these four moons, though you say they are but little secondary planets, appointed to give light to another planet during its night. Do not doubt it, replied I ; these planets are not less worthy to be inhabited, for being obliged to turn round another planet of greater consequence. I would have then, says she, the people of these four moons, to be so many colonies under Jupiter's

(10) *Their perpetual play of eclipses.* These satellites of Jupiter were first observed by Simon Marius, mathematician to the Elector of Brandenburg, about the end of November 1609, who took notice of three little stars moving round Jupiter's body, and proceeding along with him ; and in January following discovered a fourth.

In January 1610, Galileo also observed the same in Italy ; and that year published his observations. In honour of his patron, the Grand Duke of Tuscany, he called them *Astra Medicæ*, Medicæan stars : Marius, the first discoverer, called that next Jupiter, *Mercurius Jovialis*, Jupiter's *Mercury* ; the second, Jupiter's *Venus* ; the third, Jupiter's *Jove* ; and the fourth, Jupiter's *Saturn*. One Anthony Maria Schyræus de Rheita, a capuchin of Cologne, imagined, that besides these four, he had discovered five others, on the 29th of December

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piter's government; they should, if it were possible, receive their laws and customs from him, and consequently pay him a kind of homage, and not view this great planet without deference. Would it not be convenient too, says I, that they should send deputies with addresses to him, to take an oath, and to assure him of their fidelity; yet, I doubt, if he has certainly a more absolute command over his moons, than we have over ours; his power, after all, is but imaginary, and consists chiefly in making them afraid; for that moon, which is nearest to him, sees that he is sixteen hundred times larger than our moon appears to us; for, in truth, he is so much larger than her; so that this formidable planet hovers continually over their heads, at a very little distance; and if the Gauls were afraid heretofore,

1642; and in honour of URBAN VIII, the Pope then reigning, denominated them *Sydera Urbanaſtorum*. But upon Nauda's communication to Gassendus, who had observed Jupiter on the same day, he soon perceived, that the monk had mistaken five fixed stars in the effusion of the water of aquarius, marked in Tycho's catalogue 24, 25, 26, 27 and 28, for satellites of Jupiter: whence it is no wonder they should appear to the discoverer to move a contrary way to that of the rest, viz. from west to east. See *Epist. Gassend. ad Gab. Naud. de Novem Stellis circa Jovem viſis*.

The principal phenomena of these satellites are as follow. First, they all disappear in a clear sky, when Jupiter interposes between them and the sun; that is, are eclipsed by him: these happen almost every day. Flamsteed and Cassini have published tables, wherein their immersions into Jupiter's shadow, and emersions again

tofore, that the heavens would fall on them, and crush them to pieces, I think the inhabitants of these moons may well be apprehensive that Jupiter will, at some time or other, over-whelm them. I fancy, says the lady, they are possessed with that fear, which is given them because they have no eclipses: every one has their peculiar folly; we are afraid of an eclipse, and they, that Jupiter will fall on their heads. It is very true, says I, the inventor of the third system I told you of the other night, the famous Tycho-Brahe, (one of the greatest astronomers that ever lived) did not apprehend the least danger from an eclipse; he past his whole life in contemplating them, and never shewed any dread, when every body else was under the greatest consternation; but what apprehensions do you think he entertained instead of them? This great man was so unaccount-

gain are computed to hours and minutes. A second kind of eclipses they undergo, are called occultations, rather than obscurations; wherein the same satellites coming too near to Jupiter's body, are lost in his light; which Ricciolus calls, *occidere zeufiace*, setting jovially. In which case, Jupiter's nearest satellite exhibits a third kind of eclipse, being observed like a macula or dark round spot, passing over Jupiter's disk, with a motion contrary to that of the satellite; just as the moon's shadow projected on the earth will appear to do to the lunar inhabitants.

These eclipses of Jupiter's satellites furnish the best means of finding the longitude of places; and if observations of them could be readily taken at sea, they would prove of infinite service for this purpose. It is said, that one Mr. Irwin, a gentleman of Ireland, has lately

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unaccountably superstitious, that if an hare did but cross him, or an old woman bolt upon him at his first coming out, he instantly thought his journey would be unfortunate; he shut himself up for that day, and would not be concerned in the least business. It would be very unreasonable, replied she, since such a man could not free himself from the fear of eclipses, without falling into some other whimsy as troublesome, that the inhabitants of those moons of Jupiter, whereof we were just speaking, should escape upon easier terms: but we will give them no quarter; they shall come under the general rule, and if they are free from one error, they shall fall into another, as an equivalent: but as I cannot pique myself in being able to guess, pray clear up one more difficulty to me, which has given me some pain

lately invented an apparatus for observing these eclipses on ship-board, which prevents the motion of the ship from disturbing the operation. Certain it is, that eclipses of the first satellite, are much surer than those of the moon; and withal happen much oftner, there being generally two of those eclipses in three days; beside, the manner of applying them is very easy, the difference of time on which they happen, as set down in the tables, from that of observing the phenomenon, gives the difference of longitude from the meridian of the place the tables were calculated for, to the place of observation.

Both Cassini and Maraldi have frequently observed very surprising changes in the apparent magnitudes of the satellites, when there was nothing in their distance, either from the earth, sun, or Jupiter, to occasion such variations. For example, the fourth satellite, which is frequent-

pain for several minutes. Tell me, if the earth be so little in comparison of Jupiter, whether his inhabitants do discover us? I fear, we are wholly unknown to them! Indeed, I believe not, says I; for if we appear to him one hundred times less than he appears to us, judge you if there be any possibility of his seeing us: yet this we may reasonably conjecture, that there are astronomers in Jupiter, who, after they have with great pains made the most curious telescopes, and taken the clearest nights for their observations, may have discovered a little planet in the heavens, which they never saw before; if they publish their discovery in the journal of the learned in that country,

frequently observed to be the least of all, sometimes appears the largest, sometimes only appears equal, and sometimes less, than any of the rest. As they are illuminated by the sun, even when immersed in the light of Jupiter, and yet, notwithstanding this, they sometimes appear dark, and sometimes disappear, there must be some changes in their atmospheres, to prevent the equable reflection of the sun's rays, from the several parts of the atmosphere. To the same cause it is owing, that their shadows on the disk of Jupiter, are sometimes seen larger than themselves. Their periods are found from their conjunction with Jupiter, after the same manner as those of the primary planets are found from their oppositions to the sun.

By this method Cassini found the periods of the several satellites to be as follow.

	Days.	Hours.	Min.	Seconds.
First satellite	1	18	28	36
Second	3	13	18	52
Third	7	3	59	40
Fourth	16	16	05	06

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try, most people know not what they mean, or laugh at them for fools; nay, the philosophers themselves will not believe them, for fear of destroying their own opinions; yet some few rational people may be a little curious, and hearken to it; they continue their observations, discover the little planet again, and at length are assured it is no vision; then they suspect it has a motion round the sun, and after a thousand observations, find that it compleats this motion in a year; and at last (thanks to the learned) they know in Jupiter that our earth exists in the universe; every curious body runs to peep at it at the end of a telescope, though it appears so small, as to be scarcely discernible.

If

As in the primary planets with regard to the sun, so with the satellites with regard to the primaries, the squares of their periodical times are in a triplicate ratio of their distances therefrom. To determine their distances by observation, they measure them with an instrument, called a micrometer, in semi diameters of Jupiter. These distances, according to Cassini, are as follow.

Distance from Jupiter's centre.

The first satellite is	$5\frac{2}{3}$	} Semi-diameters of Jupiter.
The second	9	
The third	14	
The fourth	$25\frac{1}{3}$	

Hence, as the semi diameter of Jupiter, is equal to $27\frac{8}{9}$ semi diameters of the earth, the distance of the first satellite from the centre of Jupiter is 166 semi-diameters of the earth; that of the second 249 and a half; that of the third, 388; and that of the fourth, 884. All these moons are parallel to the plane of the ecliptic; and consequently they seem to move backward and forward in a right line.

If it was not, said the marchioness, that it is a little mortifying to know, that in Jupiter we are not discovered without their best telescopes; it must be pleasant, to see the astronomers of both planets, levelling their tubes at one another, and mutually asking, What world is that? What people inhabit it? Not so fast neither, replied I; for though they may from Jupiter discover our earth, yet they may not know us; that is, they do not in the least suspect it is inhabited; and should any one there chance to have such a fancy, he might be sufficiently ridiculed, if not prosecuted for it; for my part, I believe they have work enough to make discoveries on their own planet, not to trouble their heads with ours. It is so large, that if they have any such thing as navigation, their Columbus's could never want employment; why, I warrant you, they have not yet discovered the hundredth part of their planet. But, on the contrary, Mercury is so small, they are all (as it were) near neighbours, and it is but taking a walk to go round that planet. But if we do not appear to them in Jupiter, they cannot certainly discover Venus and Mercury, which are much less than the earth, and at a greater distance; but in recompence for this loss, they see Mars, their own four moons, and Saturn with his; this, I think, is work enough for their astronomers; and nature has been so kind to conceal from them the rest of the universe.

Do.

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Do you think it a favour then, says she? Yes certainly, replied I, for there are sixteen planets in this great vortex : nature, to save us the trouble of studying the motions of them all, shews us but seven, which, I think, is very obliging, though we knew not how to value her kindness ; for we have discovered the other nine which were hid from us, and so we have rendered the science of astronomy much more difficult than nature designed it.

If there are sixteen planets, says the marchioness, Saturn must have five moons. It is very true, replied I, and with much more justice, as he is thirty years in going round the sun ; and there are consequently in him some countries, where their night is fifteen years long. For the same reason, that upon the earth, which revolves round the sun in one year, there are nights six months long at the poles. But Saturn being twice as far from the sun as Jupiter, and consequently ten times farther than us, doth his five moons give him sufficient light ? No, he hath besides a very remarkable resource, and the only one in all the universe. Nature has encompassed him round with a great circle or ring ; this being placed beyond the reach of the shadow, which the body of that planet casts, reflects the light of the sun continually on those places where they cannot see the sun at all, and reflects it nearer, and with more force, than all the five moons, because it is less elevated than the lowest of them.

I protest,

I protest, says the marchioness, this is very surprising, and yet all is contrived with such great order, that it is impossible not to think, but nature took time to consider the necessities of some animated beings, and that the distribution of these moons was not a work of chance; for they are only divided among those planets which are farthest distant from the sun, Jupiter and Saturn; indeed it was not worth while to give any to Mercury or Venus, they have too much light already; and they esteem their nights (as short as they are) a greater blessing than their days. But pray, why has not Mars a moon too? It seems he has none, though he is much farther than the earth from the sun. It is very true, says I, no doubt but he has other helps, though we do not know them. You have seen phosphorus, both liquid and dry, how it receives and imbibes the rays of the sun, and what a great light it will cast in a dark place; perhaps Mars has many great high rocks which are so many natural phosphoruses, which, in the day-time, take in a certain provision of light, and return it again at night; what think you, madam, is it not a very pleasant sight, when the sun is down, to see those lighted rocks, like so many glorious illuminations, made without any art, and which can do no manner of hurt by their heat? Besides, there is a species of birds in America, which reflect such a light, that you may read by it in the darkest night; and who knows but Mars may have great flocks of these fowl, that, as soon as it is
night,

night, disperse themselves into all parts, and spread from their wings a new day?

I am not at all contented, says she, either with your rocks or your birds; I confess, it is a pretty fancy, but it is a sign that there should be no want of moons in Mars, since nature has given so many to Saturn and Jupiter; yet if all the other worlds that are distant from the sun have moons, why should Mars only be excepted? Ah, madam, says I, if you mix philosophy with all your researches, you will find exceptions in the very best system; there are always some things that agree extremely well, but then there are others which do not match at all; those you must leave as you found them, if ever you intend to make an end: we will do so by Mars, if you please, and say no more of him; (11) but to return to Saturn. We should be greatly astonish-
ed

(11) *But to return to Saturn.*] Saturn is situated farthest from the earth and sun of all the planets. He shines but with a feeble light, because of his great distance, on which account, though very large, he appears the smallest of the planets. He revolves round the sun, according to Kepler, in 29 years, 174 days, 4 hours, 58 minutes, 25 seconds, and 30 thirds; whence his diurnal motion must be 2 min. 0 sec. 36 thirds, though De la Hire makes his motion 2 min. 1 second. The inclination of his plane to that of the ecliptic is 31 deg. and upwards. His mean distance from the sun is 326925 semi diameters of the earth, or 777,000,000 English miles; and from the earth 21,000 of the earth's semi-diameters. According to Huygens, his smallest diameter is 30 seconds: the proportion of his diameter to that of the earth, as 1 to 8000, that of Saturn being 67870 miles.

ed if we were in that planet, to see suspended over our heads, during the night, this great ring, in the form of a semi-circle, that reaches from one end of the horizon to the other, which, reflecting the light of the sun, performs the office of a continual moon. And must we not inhabit this ring too, says she, smiling? I confess, says I, in the humour I am in, I could almost send colonies every where; and yet I cannot well plant any there, it seems so irregular an habitation; but for the five little moons, I cannot avoid peopling them; though some think this ring is a circle of moons, which follow close to one another, and have an equal motion; and that the five little moons have escaped out of this circle; if so, how many worlds are there in the vortex of Saturn? But let it be how it will, the people
in

miles. Dr. Halley observes, in his preface to the catalogue of the fixed stars, that he has found Saturn to have a slower motion, than is assigned him in the tables. It is doubted, whether, like the other planets, he revolves on his axis; it does not appear from any observations; and there is one circumstance which seems to argue the contrary, *viz.* that whereas the earth, and other planets, which we know do revolve on their axes, have their greater diameter at the equator, not at the poles; but nothing like this is observable in Saturn.

His distance from the sun being ten times greater than that of the earth from the same, it is found that the apparent diameter of the sun, seen from him, will not exceed 3 minutes, which is but little more than twice the diameter of Venus. The sun's disk, therefore, to an inhabitant of Saturn, will appear one hundred times less than it does to us, and both its light and
heat

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in Saturn live very miserably, even with the assistance of this ring. It is true, it gives light to them, but it must be a very poor one, when the sun seems to them but a little pale star, whose light and heat cannot but be very weak at so great a distance, it appearing to them one hundred times less than to us; they say Greenland is a perfect bagnio, in comparison of this planet, and that they would expire with heat in our coldest countries; if they had our water, it would not be water with them, but a polished stone, or marble; and spirit of wine, which here never freezes, would there be as hard as our diamonds.

You give me, says she, such an idea of Saturn, as makes me shiver with cold; and that of Mercury, puts me into a fever. It cannot be otherwise, replied I; for the two worlds, which
are

heat be diminished in the same proportion. His appearances or phases, are very various and extraordinary, and have long perplexed the astronomers, who could not divine the meaning of such an irregularity: thus Hevelius observed him to consist sometimes of one circle or sphere, sometimes of three, sometimes of a sphere with handles, sometimes of an oval with the same, and sometimes of a circle with cusps or points. But Huygens plainly shewed, that all these appearances were owing to the imperfection of the glasses which that author had used. Huygens, upon observing him attentively, with much better glasses, reduced all these phases to three principal ones, *viz.* round, handled, and armed. All these are owing to a piece of amazing furniture peculiar to this planet, *viz.* a ring which surrounds his middle like an arch, or the wooden horizon of a globe, at a distance therefrom. The diameter thereof more than
double

are the extremities of this great vortex, must be opposite in all things. They must then, says she, be very wise in Saturn; for you told me they were all fools in Mercury. If they are not wise, says I, yet they have all the appearances of being very phlegmatic; they are people that know not what it is to laugh; they take a day's time to answer the least question you can ask them; and are so very grave, that were Cato living among them, they would think him a merry-andrew.

A fancy

double of the planet, which it encompasseth, the former containing 45 diameters of the earth, the latter only 20. When raised enough to be out of the shadow of the body of Saturn, it reflects the light of the sun very strongly. The thickness of this ring, Keil observes, takes up one half of the space, between its outer or convex surface, and the surface of the planet. This ring is found to be a solid, opaque, but smooth and even body. It was Galileo that first discovered that the figure of Saturn was not round; but it was Huygens that first found, that its inequality was in the form of a ring, the discovery of which he published in 1659, in his *Systema Saturnianum*. The plane of the ring is inclined to that of the ecliptic in an angle of $29^{\circ} 30$ minutes. By some spots discovered in this ring, it is found to turn round Saturn. A thing that the people of that planet must see; also its being brighter on the inside than on its outside; for we can perceive it so at this immense distance. The inhabitants of Saturn within his polar circles CAD, EBF. Plate IV. fig. 1. can never see this ring. But from all other parts of his body, they continually see it for fourteen years and nine months of our time, being half of his year, and the other half it is hid from their sight. Those that dwell between the polar circles CD, EF, and the æquator,

T V,

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A fancy has entered into my head, says she, that the inhabitants of Mercury are all life, and the inhabitants of Saturn quite the contrary; but among us, some are brisk, and some are dull; it is, I suppose, because our earth is placed in the middle of the other worlds, and so we participate of both extremes; there is no fixed or determinate character among us; some are made like the inhabitants of Mercury, others like those of Saturn; and we are a mixture of the several kinds which are found in the rest of the planets.

I own,

TV, all the time the sun enlightens that part opposite to them, have every night a sight of a piece of it NI, NK, resembling a shining bow, rising from the horizon, exceeding bright from east to west, but darkened in the middle by Saturn's shadow at N, which extends commonly to its outermost rim. After midnight this shadow, to those on the north side of the æquator, moves slowly to the right hand, but to the left to those in the southern hemisphere. In the morning it grows paler like the moon, leaving behind it, indeed the appearance of a bow, but at length it is lost in the surrounding atmosphere. Under the ring between TI, and VQ, there is always a dark shadow or belt which surrounds the body of Saturn, as the ring prevents the sun to shine on that part, for a considerable time, and hides part of the fixed stars from it besides. It must be an amazing thing to lose the sun's light in a moment, without knowing the cause, all which time, their five moons are their only comfort. The other half of their year, the other hemisphere, undergoes the same eclipse also, as the first did. At the equinoxes, when the sun is in the same plane with the ring, the Saturnians cannot well perceive it; no not even with our glasses, because of the then darkness of the inward edge.

Plate IV. Fig. 2. represents, how the ring appears

144. CONVERSATIONS on the

I own, says I, that I approve of the idea. Me thinks, it is pleasant to be composed of such a fantastical assembly, that one would think we were collected out of different worlds; we need not travel abroad, when we see the other worlds in epitome at home.

I am

pears to the inhabitants of Saturn, who dwell between the arctic circles, and the equinoctial of that planet; it being a projection of Saturn upon the plane of the equinoctial, the pole being at S, and the equinoctial the outward limit of that planet.

H O, The horizon both of the ring and body of the planet.

H R, O R, The illuminated part of the ring above the horizon of Saturn.

D D, The upper part of the ring, obscured by the body of Saturn, as it must appear at midnight, after which this dark part moves slowly to the right hand to those on the north side of the æquator, and to the left to those on the opposite side.

T, The sun, illuminating the ring, and lower hemisphere of Saturn, except that part directly under the ring V.

The inhabitants of this planet must enjoy a very small portion of solar light and heat, ninety times less than ours. So that our poles are actually warmer than his torrid zone. Yet it is possible it may have creatures formed accordingly, proper to bear this intense cold. For we have animals here, that, in the severest winter, bear cold without any concern. Nay, some have been put into freezing mixtures, composed of nitre and snow, which is so very cold, that our fingers cannot bear the touch of it; others have been frozen up in a cylinder of ice for the space of half an hour, and yet it has not killed them. Therefore it is only a constitution fitted to the nature of the element, that is necessary for the enduring any degree of heat or cold.

The

I am sure, says the marchioness, we have one great convenience in the situation of our world: it is not so hot as Mercury and Venus, nor so cold as Jupiter or Saturn; and our country is so temperately placed, that we have no excess either of heat or cold. I have heard of a philosopher, who gave thanks to nature that he was born a man, and not a beast; a Greek, and not a Barbarian; and for my part, I render thanks that I am seated in the mildest planet of the univiverse,

H

and

The plane of Saturn's ring is most of all open to the view of a spectator on the earth, when he is in about the 20th degree of Sagittarius; which place he possessed about the end of the year 1752; and then shewed nearly the whole body of the planet within the ring. See Plate I. fig. 4.

As he moves on nearly at the rate of 12 degrees in a year, the ring keeps always parallel to itself, and becomes more and more elliptical or shaped of a long oval, till he arrives at the 11th degree of Aquarius; proceeding from thence to about 10 degrees of Pisces, the ring seems little more than as a line that lies over the planet, and at a small distance at either side, see Plate I. fig. 7. and thus it appeared in the beginning of 1759. Soon after which it intirely disappears, as in fig. 5. And in the beginning of this present year 1760, it arrives to the place of the nodes of the ring, which is in about 20 degrees of Pisces. Then the plane passing through the eye of the spectator, projects the edge of the ring into a strait line, just over the middle of the disk of the planet; consequently no part of the ring appears for the first six months of this year, but in a strait line; nor will it appear to be curved until he enters Aries, which will be in the year 1761, when the other, or southern side of the ring, will be enlightened by the sun. Thus every successive year, the phases of the ring will turn

and in one of the most temperate regions of that planet. If you will believe me, madam, you have more reason, says I, to give thanks that you are young, and not old; that you are young and handsome, not young and homely; that you are young, handsome, and a French woman, and not young, handsome, and an Italian; these are more proper subjects for your thanks, than the situation of your vortex, or the temperature of your country.

Pray,

again, till seven years are completed, when the ring will be again most open to the telescopic view of the spectator, which will be in the latter end of the year 1767; and the same variety will again appear during the remaining half of his orbit. All which phenomena are most curiously represented by an Orrery. Mr. Whiston, in his memoirs of Dr. Clarke, says, that the Doctor's father once saw a star through one of the opens of Saturn's ring.

The summer and winter of Saturn is more different than ours, as their axis declines above 31 degrees, and ours not more than 23 and a half.

Upon this account, his five moons must decline very much from the path that the sun seems to move in, and his inhabitants can never see any of them at full but just at the equinoxes, two of which fall out in thirty of our years. It is this position too of its axis, that is the cause of those most delightful appearances, and wonderful prospects that its inhabitants enjoy, occasioned by its ring, as already mentioned.

The satellites always turn the same face to Saturn, as our moon does to us, and as those of Jupiter do also to him; the length of day and night, in these moons, is always equal to the time of their revolution. For example, the fifth moves round Saturn in 74 days, and the days and nights there are equal to 37 of ours; both their summer and winter, as Saturn moves round the sun.

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Pray, sir, says she, let me give thanks for all things, even for the very vortex in which I am planted: our proportion of happiness is so very small, that we should not lose any, but improve continually what we have, and be grateful for every thing, though ever so common or inconsiderable. If nothing but exquisite pleasure will serve us, we must wait a long time, and be sure to pay too dear for it at last. You will promise me then, replied I, that, if I entertain you with these lively pleasures, when you think of vortexes, you will not forget an humble servant of your lady-

H. 2 ship's.

fun in 30 years, are 15 years long. Therefore, it is impossible but that their way of living must be very different from ours; having such tedious winters, and such long watching and sleeping times.

Mr. Huygens discovered the first of these moons in 1655, with a twelve foot telescope. Cassini found out the other four (he called them Ludovician stars, in honour of Lewis XIV.) viz. the two innermost in 1684, by the help of Campani's glasses, of 100, and 136 feet long; the third in 1672, by another telescope of 35 feet; and the fifth (that of Huygens being the fourth) in 1671, by a telescope of 17 feet. All the phenomena mentioned to belong to Jupiter's moons, in a foregoing note, probably belong also to these. Thus they are seen larger and smaller; the fifth is also sometimes found eclipsed, &c.

The periodical times of the satellites of Saturn, according to M. Cassini, are as follow:

	Days.	Hours.	Min.	Sec.
First Satellite	1	21	18	31
Second	2	17	41	27
Third	4	13	47	16
Fourth	15	22	41	6
Fifth	74	7	53	57

Their

ship's. I esteem it only a pleasure, answered the lady, while it diverts me with something new, but no longer. I will engage for doing it to-morrow at least, replied I; for the fixed stars are superior to whatever you have yet seen or heard.

Their distances from the centre of Saturn, according also to Cassini:

First Satellite	$4\frac{1}{2}$	} Semi-dia- meters of Saturn, or	} $\left\{ \begin{array}{l} 1 \\ 1\frac{1}{2} \\ 4\frac{1}{2} \\ 4 \\ 10\frac{1}{2} \end{array} \right\}$	} Diamet. of Saturn's ring.
Second	$5\frac{1}{2}$			
Third	8			
Fourth	18			
Fifth	54			

The great distance between the fourth and fifth satellite, gave occasion to Huygens to suspect that there might be some intermediate one; or else that the fifth might have some other satellite moving round it as its centre.

These do not, like the moons of Jupiter, always appear in a strait line east and west to us, because the edge of the orbits of Jupiter's moons, lie right before the eye, or are nearly in the plane of the earth's orbit. Whereas, those of Saturn are inclined thereto in an angle of 31° degrees; and appear to us to move round him in a long oval or elipsis.





The FIFTH EVENING.

*Shewing that the fixed Stars are so many Suns,
every one of which gives light to a World.*

THE marchioness was very impatient to know what would become of the fixed stars; are they peopled, says she, as the planets are, or are they not inhabited at all, or, in short, what do you make of them? You may soon guess, says I, (1) the fixed stars cannot be less distant from the earth than 27650 times the distance from this to the sun; nay, if you anger an astronomer, he will set them farther. The distance from the sun to Saturn the farthest planet, is only 330 millions
H 3 of

(1) *The fixed stars cannot be less distant from the earth.*] Let us take one of the fixed stars, supposed to be the nearest to us, as being the brightest and largest, namely Sirius, or the Dog-star. Now this, by accurate observation (see Mr. Huygens in his *Cosmotheoreos*, p. 137.) hath been found to be in appearance 27664 times less than the sun; and consequently he is as much farther from us than the sun, as his apparent diameter is less than the sun, which will amount to above two millions of millions of English miles. And if so, what an immensurable space is the firmament? wherein a great number of stars, lesser and lesser, and consequently farther and farther off, are seen with our naked eye, and many more discovered with glasses; and still multitudes

of leagues ; this is nothing in comparison of the distance from the sun, or from the earth to the fixed stars; it is almost beyond arithmetic. You see their light is bright and shining, and did they receive it from the sun, it must needs be very weak, after so long a passage ; then judge how much it must be again wasted by reflexion ; for if the stars returned it back to us at such an immense distance, and if it were reflected, it is impossible it should be so clear and strong as the light of a fixed star is, which cannot but proceed originally from itself ; so that, in a word, all the fixed stars are luminous bodies in themselves, and so many suns.

I perceive, says the marchioness, where you would carry me ; you are going to tell me, that if the fixed stars are so many suns, and our sun the centre of a vortex which turns round him, why may not every fixed star be the centre of a vortex that turns round it ? Our sun enlightens the

titudes of others with better glasses ; and, in all probability, many others that escape the reach of our utmost art to descry ; which may consequently be as far distant from those we see, as they are from us. Thus the fixed stars, no less in magnitude, in all probability, than the sun, degenerate into so many points, yea, escape our eye, on account of their immense distance ; nay, more than this, it causeth even the great orbit which our earth describes about the sun, to sink almost into a point, or, at least, into a circle of but a few seconds diameter.

When we reflect, that there are, in all probability, stars vastly more remote than those which appear to our unaided sight ; stars whose effulgence, though travelling even since the creation, is not yet arrived, ac-

cord-

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the planets that belong to him; why may not every fixed star also have planets to which they give light? I will not contradict you, replied I; I shall make no other answer but that of Phædrus to Enone, 'It is thou who hast named it.'

But I see the universe so large, says she, that I know not where I am, or what will become of me; what, is it all to be divided into vortexes thrown confusedly one among another? Is every star to be the centre of a vortex, as large as ours? Is that vast space which comprehends our sun and planets, but an inconsiderable part of the universe? And are there as many such spaces, as there are fixed stars? I protest it is dreadful, the idea confounds and overwhelms me. And for my part, replied I, it gives me satisfaction; when the heavens appeared to me as a little blue vault,

H 4

cording to the same Mr. Huygens, on our coats, although the motion of light is so surprizingly swift, as to pass through ten millions of miles in a single minute. How vast then! and beyond all reckoning, and beyond all mensuration must the spaces of the universe be!

While the mind is distended with the grand idea; or, rather, while she is dispatching her ablest powers of piercing judgment, and excursive fancy, and finds them all drop short, all baffled by the amazing subject; permit us to apply that beautiful exclamation and noble remark of a favourite poet.

Say, proud arch,
Built with divine ambition; in disdain
Of limit built; built in the taste of heav'n!
Vast concave! ample dome! wast thou designed
A meet apartment for the Deity?
Not so: that thought alone thy state impairs;

Thy

vault, stuck with stars, methought the universe was too strait and close, I was almost stifled for want of air; but now it is enlarged in height and breadth, and a thousand and a thousand vortexes taken in, I begin to breathe with more freedom, and think the universe to be incomparably more magnificent than it was before. Nature has spared no cost, even to profuseness; and (2) nothing can be so glorious, as to see such a prodigious number of vortexes, whose several centres are possessed by a particular sun, which causes divers planets to turn round it. The inhabitants of a planet of one of these innumerable vortexes, behold on all sides these luminous centres of the vortex, with which they are encompassed;

Thy lofty sinks: and shallows thy profound;
And streightens thy diffusive.

Night-Thoughts, No. IX.

Which thought is founded on these words of sacred writ, *Who is able to build Him an house, seeing the heaven, and heaven of heavens, cannot contain him?*

2 Chron. ii. 6. and 1 Kings. viii. 27.

(2) *Nothing can be so glorious, as to see such a prodigious number of vortexes.*] Concerning vortexes, we have said enough already, in the foregoing notes, to shew their absurdity, and the impossibility of their existence.

But if, instead of vortexes, we may read systems, that is, a number of bodies, moving round a common centre, our author's idea is indeed very noble; that such a number of systems, or worlds, may exist without the aid of vortexes, is certain from the Newtonian philosophy, of which we have already given a sketch, p. 30, &c. This infinite number of worlds is called, to distinguish it from the rest, the *new system*, which is the same as the Copernican, in regard to the situation of the sun and the planets
revolv-

nets, belonging to one of those vortexes, whose number is infinite: we ourselves, for whom the same expression may serve, must confess, that we scarce know where we are, in the midst of so many worlds; for my own part, I begin to see the earth so minutely small, that I believe, from henceforward, I shall never be concerned at all for any thing: one cause why we so eagerly desire to make ourselves great, why we are always designing, always troubling and harassing ourselves, is certainly because we are ignorant of these vortexes; but now, I hope, my new lights will in part justify my laziness, and when any one reproaches me with my indolence, I will answer, 'Ah, did you but know what the fixed stars are!' It was not fit, says I, that Alexander should know what they were, for a certain author [Huygens] who maintains that the moon is inhabited, very gravely tells us, that Aristotle (from whom no truth could be long concealed) must necessarily have been of an opinion, backed with so much reason; but yet he never durst acquaint Alexander with the secret, lest he should run mad with despair,

This system is by far the most magnificent of any, and worthy of an infinite creator, whose power and wisdom, as they are without bounds and measure, so may, in all probability, exert themselves in the creation of many systems as well as one. And as myriads of systems are far more for the glory of the Deity, and more demonstrate his attributes than one; so it is no less probable than possible; consequently there may be many besides this which we have the privilege of living in. See a representation of the new system, Plate II. fig. 1.

despair, when he knew there was another world which he could not conquer. But with much more reason was this mystery of vortexes and fixed stars, kept secret in Alexander's time; for if they had been known in those days, it had been but an ill way of making one's court, to have said any thing of so many other worlds to that ambitious prince; for my part, I that know them, am not a little troubled to find, that I cannot draw any utility from all the knowledge I have of them; the most they do, according to your way of reasoning, is but to cure people of their ambition, and their unquiet restless humout, which are diseases I am not at all troubled with; I confess, I am guilty of so much weakness, as to be in love with what is beautiful; that is my distemper, and I am confident that vortexes can never cure it: though the other worlds may render us short sighted, they cannot spoil fine eyes, or a pretty mouth; their value is still the same, in spite of all the worlds that can possibly exist.

This love, replied the marchioness, laughing, is a strange thing; let the world go how it will, it is never in danger; there is no system can do it any harm. But, tell me freely, is your system true? Pray, do not conceal any thing from me; I will keep your secret very faithfully; it seems to have for its foundation, but a slight probability, which is, that if a fixed star be in itself a luminous body, like the sun, then by consequence, it must, as the sun is, be the centre and soul of a world, and have its planets turning round about it:

it. But is there an absolute necessity that it must be so? Hear me, madam, says I; since we are in the humour of mingling the follies of gallantry with philosophy, I must tell you, that in love and the mathematics, people reason much alike: allow ever so little to a lover, yet presently after you must grant him more; nay, more and more; and he will at last go a great way: in like manner, grant a mathematician but one minute principle, he immediately draws a consequence from it, to which you must necessarily assent; and from this consequence another, till he leads you so far (whether you will or no) that you have much ado to believe all he has proved, and what you have already assented to. These two sorts of people, lovers and mathematicians, will always take more than you give them. You grant, that when two things are like one another in all visible respects, it is possible they may be like one another in those respects which are not visible, if you have not some good reason to believe otherwise: now this way of arguing have I made use of. The moon, says I, is inhabited, because she is like the earth; and the other planets are inhabited, because they are like the moon; I find the fixed stars resemble our sun; therefore I attribute to them what is proper to him: you have gone too far to be able to retreat, therefore you must go forward with a good grace. But, says the lady, if you build upon this resemblance, or likeness, which is between our sun and the fixed stars, then, to the people of another

great

great vortex, our sun must appear no larger than a small fixed star, and can be seen only when it is night with them. Without doubt, madam, says I, it must be so: our sun is much nearer to us, than the suns of other vortexes, and therefore its light makes a much greater impresson on our eyes than theirs do: we see nothing but the light of our own sun; and when we see him, it darkens and hinders us from seeing any other; but in another great vortex, there is another sun, which rules and governs; and, in his turn, extinguishes the light of our sun, which is never seen there but in the night, with the rest of the other suns, that is, the fixed stars; with them our sun is suspended in the great arched roof of heaven, where it makes a part of some constellation: the planets which turn round about it, (our earth for example) as they are not seen at so vast a distance, so no body will so much as dream of them. All the suns that are day-suns in their own vortexes, are but night-suns or fixed stars in other vortexes: in his own world or sphere, every sun is single, and there is but one to be seen; but every where else they serve only to make up a number of stars. May not these worlds, replied she, notwithstanding this great resemblance between them, differ in a thousand other things; for though they may be somewhat alike in this one particular, they may greatly differ in others.

It is certainly true, says I; but the difficulty is to know wherein they differ. One vortex may have many planets that turn round about its sun,
another

another may have but a few: in one there may be inferior or lesser planets, which run about those that are greater; in another, perhaps, there may be no inferior planets; here all the planets are got round about their sun, in form of a little squadron; beyond which may be a large void space, which reaches even to the neighbouring vortexes: in others, the planets may make their revolutions towards the extremity of their vortex, and leave the middle void. I doubt not, but that there may be vortexes also quite void, without any planets at all; others may have their sun not exactly in their centre; and that sun may so move, as to carry its planets along with it: some may have planets, which, in regard of their sun, rise and set according to the change of their equilibrium, which keeps them suspended. In short, what farther variety can you wish for? But, I think, I have said enough for a man that was never out of his own vortex.

You have not said too much, replied the marchioness, considering what a multitude of worlds there are; what you have said is scarce sufficient for five or six; and from hence I see thousands, I may say, of millions.

What would you say, madam, if I should tell you, there are many more fixed stars than those you see? (3) And what an infinite number are discovered with glasses, which are not perceptible to

(3) *And what an infinite number are discovered with glasses.*] Says Mr. Derham, in viewing the planets with

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to the naked eye; and that in one single constellation, where perhaps we count twelve or fifteen, there are as many more to be found with a telescope as usually appear in the whole hemisphere.

I submit, says she, and beg your pardon: you quite confound me with worlds and vortexes. O, madam, I have a great deal more to tell you, replied I; (4) you see that whiteness in the sky, which some call the milky-way; can you imagine what that is? Why, it is nothing but an infinity of small stars, not to be seen by our eyes, because they are so very little; and they are sown so thick, one by another, that they seem to be one continued whiteness: I wish you had a glass,

to
with my longer glasses (especially the planets of a weaker light) it often falls out, that divers of the fixed stars, and some of them very small, present themselves at the same time within the glass, notwithstanding it's area is not sufficient to contain both Jupiter and his most distant satellites; by which means, it is sometimes difficult to distinguish, between those fixed stars and the satellite of the planet. Thus, I have been sometimes ready to fancy, that I saw one or more satellites near Mars, until by future observations, I perceived they were only some of the telescopic fixed stars lying in the way of Mars. So about Saturn, I have often discovered the likeness of many satellites; but I am not sure I ever saw above three. From hence it is manifest, that there are, in all parts of the heavens, many stars, which present themselves to our eye through our long glasses, that are otherwise invisible to us. And this has been further confirmed since the discovery of making large reflecting telescopes.

(4) *You see that whiteness in the sky, which some call the milky-way.* Mr Derham is of opinion, that the
whiteness

to see this ant's nest of stars, and this cluster of worlds, if I may so call them; they in some sort resemble the Maldivia-islands; which are twelve thousand little islands or banks of sand, separated only by narrow channels of the sea, which a man may almost leap over: the vortexes of the milky-way are sown so thick, that I presume, the people in one world, may talk, and shake hands with those of another; at least, I believe the birds of one world may easily fly into the other; and that pigeons may be trained up to carry letters, as they do here in the Levant. These little worlds seem to vary from the general rule, by which one sun, in his own vortex, as soon as he appears, effaces the light of all other foreign suns: if you were in one of these little vortexes of the milky-way, your sun there would not be much nearer to you, and consequently, would

whiteness of the galaxy or milky-way, is not caused by the great number of fixed stars in that place, as hath commonly been thought, but partly by their light, and partly (if not chiefly) by the reflection of their planets, which stop and reflect, intermix and blend the light of their respective stars or suns, and so cause that whiteness the galaxy presents us with; which hath rather the colour of the reflected light of our moon, than of the primary light of our sun. And that there are planets enough for this purpose, "I suspect (says he) because I have some reason to imagine, that there are many more new stars in the milky-way (all which, I take to be a kind of planetary globes) than have ever yet been observed, and that many of those prodigious number of telescopic stars visible there, are of the number of new stars or planets, and not of fixed stars only. This suspicion

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would not make a much more sensible impression on your eyes, than a hundred thousand other suns of the neighbouring little vortexes: you would therefore see your heaven shine bright with an infinite number of fires, close to one another, and but at a little distance from you; so that though you should lose the light of your own particular sun, yet there would still remain visible suns sufficient beside your own, to make your night as light as day, at least the difference would hardly be perceptible; for the truth is, you would never have any night at all: the inhabitants of these worlds, accustomed to perpetual brightness, would be strangely astonished, if they should be told that there is a miserable sort of people, who, where they live, have very dark nights, and

picion I have for sometime had, but especially lately from my views of the new star that now begins to disappear in the swan's neck; which gave me occasion to inspect some other parts of that constellation, most parts of which are well replenished with a numerous train of small stars. Amongst which, sometimes methought, more have presented themselves through one and the same glass, and sometimes I have missed some that I thought I saw before: and sometimes I imagined I saw them nearer to, and sometimes farther off those stars that did constantly present themselves." These observations, the reverend author earnestly recommended to be farther enquired into; and for the doing of which, he advises that an area of the heavens may be taken in, containing as much as falls within the compass of the telescope made use of, and that a map be taken of all such stars as fall within this area, which will shew when any variations happen.

In

and when it is day with them, they never see more than one sun; certainly they would think nature had very little kindness for us, and would tremble with horror, to think what a sad condition we are in.

I do not ask you, says the marchioness, whether in those worlds of the milky-way, there are any moons; I see they would be of no use to those principal planets which have no night, and move in spaces too strait and narrow to embarrass themselves with a train of subaltern planets: yet pray take notice, that by your liberal multiplication of worlds, you have started an objection not easily answered: the vortexes whose suns we see, touch the vortex in which we are; and if it be true, that vortexes are round, how then can so many vortexes, all touch a single one? I would fain know how this may be done, but cannot reconcile it to myself.

Madam, says I, you shew a great deal of penetration in raising this doubt, and likewise in not being able to resolve it; for in itself, the thing seems extremely difficult; and, as you state the question, no answer can be given to it; and he must

In some parts of the heavens we perceive a kind of white misty spot, which at first glance seems a star; however, we can make little of it by the naked eye; but with a telescope these spots appear to be a cluster of stars filling most of the glass. They are called by astronomers *nebulous stars*, and of these there are about six or seven, to be seen in the heavens. They are placed on all celestial globes, where their situation may be regularly found at any time.

be a fool who goes about to find answers to objections which are unanswerable. If our vortex had the form of a dye, it would have six squares, or flat surfaces, and would be far from being round; and (5) upon every one of these squares, might be placed a vortex of the same figure; but if, instead of these six squares, it had twenty, fifty, or a thousand; then might a thousand vortices be placed upon it, one upon every flat; and, you may very well conceive, that the more flat faces any body has on its outside, the nearer it approaches to a round figure, just as a diamond cut on every side into a great number of faces; if the faces be very many and little, it will look nearly as round as a pearl of the same size: it is in this manner, that the vortices are round; they have an infinite number of faces on their circumference or external surface, and every one of them is joined to another vortex;

(5) *Upon every one of these squares, might be placed a vortex.*] This is an ingenious contrivance of our author, to solve the lady's difficulty, why the vortices do not intermingle and confound each other; but as no such vortices subsist, there is no necessity for this solution. The fact is, it is impossible for us to determine how the fixed stars, which are supposed to be suns in the centres of so many systems, are situated in respect to one another. But they appear to us, who can have no regular prospect of their positions, to be placed without any order or regularity, like as we should judge of a regular plantation in a large park at a distance, which would also appear to us in a confused manner, until we came near and had a distinct prospect of them, which we then should find would all form one regular design.

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vortex; these faces are not all equal and alike; but here, some are greater, and there some less: the least faces of our vortex, for example, answer to the milky-way, and are joined to all those little worlds. When two vortexes which are joined to two neighbouring faces, or leave beneath any void spaces between them, as it must often happen, nature, who is an excellent manager, and will not suffer any thing to be useless, presently fills up this void space with a small vortex or two, perhaps with a thousand, which never incommode the others, and become one, two, or a thousand worlds or more; so that there may be many more worlds than our vortex has flat surfaces to bear them. I will lay a wager, that though these little worlds were made only to be thrown into the corners of the universe, which

So doubtless, if we could have such an advantageous prospect of the fixed stars, we should find them very commodiously set in the firmament in regard to one another. And this we have great reason to conclude from that constant harmony and similitude, observable in all the works of the creation, which fall under our cognizance; this is particularly evident in this region of the universe to which we belong, and which we have a better prospect of, and can survey with our instruments, I mean the solar system. In this we find every body placed in good order, and at a due distance, according to the nicest rules of proportion. And if the great Creator hath thus wisely modelled this part of the universe, no doubt can be made, but that he hath done the same in all the other systems likewise, and that they are set at due distances from each other, and every body in each system at its proper distance also from its sun or fixed star.

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which otherwise would have been void and useless; and though they are unknown to other worlds which they touch, yet they are well satisfied with being what they are: these are the little worlds, whose suns are not to be discovered but with a telescope, and whose number is prodigious: in fact, all these vortexes are joined to one another in so admirable a manner, that every one turns round about his own sun, without changing place; and every one has such a proper motion given to it, as is most easy and agreeable to its own situation: they may take hold of one another, like the wheels of a watch, and mutually help each other's motion: and yet it is certain, that they also act contrary to one another. Every world, as we may say, is like a foot-ball, which would extend itself, if it were not prevented. But this swelling world being pressed by the next to it, returns to its first figure; then swells again, and is again depressed by the neighbouring worlds; and some philosophers affirm, that the reason why the fixed stars give a twinkling and trembling light, and (6) sometimes seem not to shine at all, is because their vortexes perpetually press our vortex, and ours again continually repulses theirs.

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(6) *And sometimes seem not to shine at all.*] The alterations that have happened in the fixed stars are very considerable; contrary to the opinion of the antients, who held, that the heavens, and heavenly bodies, were incapable of any change. And, in effect, it was near two hundred years after the time of Aristotle, before any alteration

I am in love with these fancies, says the marchioness, and am pleased with the foot-balls, which swell every moment, and sink again; and with these worlds which are always combating: but,

alteration was observed. The first was in the year 125, before the incarnation, when Hipparchus, a celebrated astronomer of Rhodes, discovered a new star to appear; on which account, he began to make a catalogue of the fixed stars, that posterity might perceive any future changes of the like kind.

Pliny says, that in this "Hipparchus dared to undertake a thing, which seemed to surpass the power of the Gods." His catalogue contained 1022 stars.

Ptolemy, the Egyptian astronomer, only enlarged this catalogue with 4 stars.

After him, Ulugh Beighi, the grandson of Tamerlane the great, made a catalogue of 1017 stars.

Next to him the noble Dane, Tycho-Brahe, already mentioned, p. 38. determined the places of 777 stars; and reduced them all to catalogue.

Kepler produced the next catalogue of 1163 stars.

After this, William, prince of Hesse, computed the places of 400 stars, by the help of his mathematicians.

Sometime afterwards, the famous jesuit Ricciolus, enlarged Kepler's catalogue to the number of 1468 stars.

It is also said, that Bayerus made a catalogue of 1725 stars.

The late incomparable astronomer royal, Dr. Edmond Halley, undertook a voyage to the island of St. Helena, to observe the stars in the southern hemisphere; and at his return, published a catalogue of 373 of them.

And lastly, the most compleat catalogue was that published by the late Mr. Flamsteed, in his *Celestial History*, which contains about 3000 stars, of which by far the greater part, are only to be seen by the telescope. Thus the situation, as to latitude and longitude, of the smallest visible fixed star, is much better known than of many cities on this globe, through which travellers daily pass.

But

but, above all, I am pleased to see how this contest keeps up the reciprocal commerce of light, which is certainly the only one that is between them.

No.

But, to return to new stars. In the year 1572, Tycho-Brahe observed another new star in the constellation Cassiopeia, which was, like Hipparchus, the occasion of his making a new catalogue. Its magnitude at first exceeded that of the largest of our stars, Syrius and Lyra; it even equalled that of Venus, when nearest the earth, and was seen in fair day light. It continued 16 months; towards the latter part whereof, it began to dwindle, and at last totally disappeared, without any change of place in all that time.

Leovicius tells us of another appearing in the same constellation, about the year 905, which resembled that of 1572; and quotes another antient observation, whereby it appears that a new star was also seen in the same place in 1264. These Dr. Kell thinks were all the same star; and does not know but it might make it's appearance again.

Fabricius discovered another star in the neck of the Whale, which appeared and disappeared several times in 1648, and 1662. It's course and motion are described by M. Bouillaud. Simon Marius discovered another in Andromeda's girdle, in 1612, and 1613, though M. Bouillaud says, it had been seen before in the 13th century. Another was observed by Kepler in Serpentarius. Another of the third magnitude in the Swan, near the bill, in 1601; which disappeared in 1626, and was observed again, by Hevelius, in 1659, till 1661; and again in 1666 and 1671, as a star of the sixth magnitude.

It is certain from the old catalogues, that many of the antient stars are now invisible. This is particularly notorious in the Pleiades, or seven stars, whereof only six are now visible to the eye; a thing long ago observed by Ovid; witness the verse,

Quæ septem dici, sex tamen esse solent.

M. Mon-

No, no, madam, says I, light is not their sole commerce; the neighbouring worlds sometimes pay visits to us, and that in a very magnificent and splendid manner: (7) comets arrive from thence, adorned with bright shining hair, venerable beards, and majestic tails; these, says the marchioness, are ambassadors, whose visits may be

M. Montanere, in his letter to the royal society, in 1670, observes, that there are now wanting in the heavens, two stars of the second magnitude, in the stem of the ship Argo and it's yard; which had been seen in the year 1664. When they first disappeared is not known; but he assures us, there was not the least glimpse of them in 1668. He adds, that he has observed many more changes in the fixed stars, even to the number of an hundred.

The appearance of new stars (says Dr. Clarke) is much better accounted for, from the theory of comets, than from their being incrufted over with an opaque matter, which being gradually undermined and burnt down, these stars shine out afresh: for though some of the fixed stars may be so very remote from us, as not to be seen by the help of our best glasses; yet, as they are fiery bodies like the sun, if any new matter or fuel be added to them, they may on a sudden blaze out, so as to be seen by the naked eye brighter than any other star; and as this fuel is devoured, they may diminish in their brightness, and, by degrees, return to their first invisible state. And that comets might probably supply them with this fuel; see Sir Isaac Newton's *Principia*, Book III. p. 481.

(7) *Comets arrive from thence.*] The ancients had very wild and confused notions of comets; some imagined them to be a vast assemblage of little stars, which met together, by reason of the inequality of their different motions, and united together into one mass, that became visible, which must again disappear as those stars separated, and each proceeded in its course.

This

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be well spared, since they serve only to fright us. They can only scare children, says I, with their extraordinary train; but, indeed, the number of such children is now a-days very great. Comets are nothing but planets which belong to a neighbouring vortex, they move towards the outside of it; but, perhaps, this vortex being differently pressed by these vortexes which encompass it, it is rounder above than below, and the lowest flat part is still towards us. These planets which have begun to move in circles above, are

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not

This opinion Aristotle easily overturned; and he substituted another equally false in its stead. According to him, comets were only a kind of transient fires, or meteors, consisting of exhalations, raised to the upper region of the air; and there set on fire, far below the moon's course. But that philosopher, here confounded comets with meteors, which last have frequently appeared in the upper regions of the atmosphere; but they are, by no means, to be accounted comets, whose distance from the earth is so immense, that they have no sensible parallax; and are consequently far above either the place of the moon, or some of the superior planets. Hevelius gives it as his opinion, that comets were formed out of the exhalations of the sun's body; in which he nearly agrees with Kepler, who maintains, that comets are generated in the æther, like fishes in the ocean, though they do not always become visible, because of their smallness, or because they lay a long time under the horizon.

But Sir Isaac Newton has shewn the fallacy of this hypothesis, by proving, that the comet of 1680, in its passage near the sun, would have been dissipated, had it been made up of exhalations from the sun and planets; for on December 8th, the distance of that comet from the sun was observed to be, in proportion to the earth,

as

not aware, that below their vortex will fail them, because it is, as it were, broken. Therefore, to continue their circular motion, it is necessary that they enter into another vortex, which we will suppose is ours, and that they cut through the extremities of it. They appear to us very high, and are probably much higher than Saturn; and, according to our system, it is absolutely necessary they should be so high, considering the prodigious distance of the fixed stars. From Saturn

as 6 to 1000; consequently the sun's heat in the comet, at that time, was to his heat with us at midsummer, as 10,00000 to 36, or twenty eight thousand times greater than with us at that time. And again, finding that boiling water is but little more than three times the heat of our dry earth, when exposed to the summer's sun, and assuming the heat of red-hot iron to be about three times as great as boiling water, he concludes, that the body of the comet, when nearest the sun, must be 2000 times as hot as red-hot iron.

The same author says, that a globe of red-hot iron, as large as the earth, would be scarce cool again in 50,000 years. If then the comet be supposed to cool 100 times as fast as red-hot iron; yet, since its heat was 2000 times greater, supposing it of the size of the earth, it would not be cool in a million of years.

Apollonius Myndius was the first who took comets to be regular stars; and ventured to foretell, that one day the periods and laws of their motion would be discovered. Astronomers however are still divided on that head. Newton, Flamsteed, Halley, and the other English astronomers, seem satisfied of the returns of comets: Cassini, and others of the French, think, it highly probable; but De la Hire and others oppose it.

Seneca says, "I cannot assent to our philosophers, nor think the comets are fires suddenly kindled, which appear

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turn downwards to the extremity of our vortex, there is a large void space without any planets. Our adversaries often ask us, to what purpose this void space serves? But let them not trouble themselves any more, I have found a use for it. It is the apartment of those strange planets, which come into our world.

I understand you, says she, we do not suffer them to come into the heart of our vortex, to mix themselves among our own planets, but we

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receive

“pear a-while, and are again extinguished; but I reckon them among the eternal works of nature. And “why,” says he, “should we wonder that comets (such a rare spectacle in the world) should not be restricted by certain laws; nor have the times of their appearing or disappearing known, as they take their courses through such prodigious intervals of space. The time will come, when a day shall bring to light, and the diligence of a future age discover, those things which now lie hid. The time will come, in which posterity will wonder, why we were ignorant of things so very plain. A person shall one day arise, who shall demonstrate into what regions the comets wander, why they move so separately from the rest of the planets, and how large, and what kind of bodies they are.”

Dr. Halley, by searching into their histories, and comparing the observations made about them, has given a table of as many as he could find well enough described to afford foundation for determining their orbits. This number is 24; all which have appeared within these 400 years in Europe. Three had their orbits and circumstances so much alike, (which, as well as the exact times of their periods, is necessary to denominate them to be the same,) and twice two others had their orbits and circumstances so very much alike also, that Dr. Halley concluded, the former three were one and the same

receive them as the Grand Seignior does the ambassadors who are sent to him; he will not shew them so much respect as to let them reside within the walls of Constantinople, but consigns them one of the suburbs of the city. Madam, says I, we and the Ottomans agree likewise in this, that as they receive ambassadors, but never send any, so we never send any of our planets into the worlds that are next us.

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same, in all probability; and that the others, were severally also one and the same comet; the first returning after 75 years, the second after 81, and the last after 129 years.

Sir Isaac Newton also discovered, and, in the new edition of his *Principia*, published his discovery, that the comet of 1680 and 1681, towards the end of its appearance, bent its course so much inward from a parabolic line, as to shew its real trajectory to be elliptical; and this in such proportion, that it's period in returning must be more than 500 years. Whiston imagined this was the comet that caused the deluge; guessed it's period to be 575 or 504 years, according as it had made either 7 or 8 revolutions since that time; and drew up tables upon both these hypotheses, when the same comet must have appeared afterwards; but, says he, not having either Hevelius's or Luvienetz's histories of comets by me, I could not then confirm this hypothesis further.

In a little time after, Sir Isaac Newton and Dr. Halley completed what he wanted, and discovered, that just such a comet had appeared the 44th year before the christian æra, the year that Julius Cæsar was killed. As also An. Dom. 531 or 532, and again A. D. 1106, and lastly in 1680, 1681, and this still, after the fore-mentioned interval of about 575 years; and they accordingly did justly conclude it to be the very same comet that appeared in those several years: so that, says Whiston,

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By this, says she, it appears that we are very proud; however, I do not yet very well know what I am to believe. These foreign planets, with their tails and their beards, have a terrible menacing countenance, it may be they are sent to affront us; but ours that are of another make, if they should get into other worlds, are not so proper to make people afraid.

Neither their beards, nor tails, madam, says I, are real, but only mere phantoms. These foreign planets differ in nothing from ours; but in entering

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Whiston, we have only the orbits of 21 comets, and the periods, at most, of only 4 of them yet known.

The first of these three, having a period of 75 years, appeared probably in 1304 and 1456, but more certainly in 1531, 1607 and 1682, and was expected in 1758; and consequently every 75 years after. In 1758, a small comet was observed, and a second in the beginning of 1759, owing probably to the watchfulness of astronomers on this occasion: but it is not certain, whether either of these was the predicted comet, as their sizes were much smaller; which might be owing to the earth being in a different part of its orbit from what it was when they appeared before, and they might be seen therefore at a greater distance, and consequently appear smaller.

The second comet, whose period is supposed to be known, appeared probably in 1475, 1556, 1718, and may not improbably be expected in 1799.

The third appeared A. D. 1582, and not improbably in 1661, and may be expected in 1789, and 1918; and so every 129 years afterwards.

The fourth, having last appeared in 1680, 1681, and having its period no less than 575 years, cannot return till A. D. 2255. As to the rest of the comets, as there are no exact histories and observations relating to them, their determination must be left to the industry of future ages.

174. CONVERSATIONS on the

tering into our vortex, (8) they seem to us to have tails or beards, by a certain sort of illumination; which their atmospheres receive from the sun, and which has not been yet well explained. But it is certain, that it is but a kind of illumination; and when I shall be better informed, I will tell you how it is done.

I should like, says she, that our planet Saturn would go take a tail and a beard in another vortex, and fright all the inhabitants of it. Then I would have him come back again, leaving his terrible accoutrements behind him, and, taking
his

(8) *They seem to us to have tails or beards, by a certain sort of illumination, which is not yet well explained.* Sir Isaac Newton shews, that the atmospheres of comets will furnish vapour sufficient to form their tails: this he argues from that wonderful rarefaction observed in our air, at a distance from the earth: a cubic inch of common air, at the distance of half the earth's diameter, or 4000 miles, would expand itself so, as to fill a space larger than the whole region of the fixed stars. Since then the air, or atmosphere of a comet, is ten times higher than the surface of the solid part, counting from the centre thereof; the tail ascending much higher, must needs be immensely rare: so that it is no wonder the stars should be visible through it. Now, the ascent of vapours into the tail of the comet, he supposes, is occasioned by the rarefaction of the matter of the atmosphere at the time the comet is next the sun. Smoke, it is observed, ascends the chimney by the impulse of the air wherein it floats, and air, rarified by heat, ascends by the diminution of its specific gravity, taking up the smoke along with it: why then should not the tail of a comet be supposed to be raised after the same manner by the sun? for the sun beams do not act on the medium they pass through,
any

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his usual place amongst our other planets, fall to his ordinary business. It is better for him, says I, not to go out of our vortex. I have told you how rude and violent the shock is, when two vortexes jostle one another, a poor planet must needs be terribly shaken, and its inhabitants in no better condition. We think ourselves very unhappy when a comet appears; but it is the comet itself which is unfortunate. I do not believe that, says she, it brings all its inhabitants with it in very good health; there can be nothing

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any otherwise than by reflection and refraction. The reflecting particles then being warmed by the action, will again warm the æther wherewith they are compounded; and this, rarified by heat, will have it's specific gravity, whereby it before tended to descend, diminished by the rarefaction; so as to ascend and carry along with it those reflecting particles whereof the tail of the comet is composed. This ascent of the vapours will be promoted by their circular motion round the sun; by means whereof, they will endeavour to recede from the sun, while his atmosphere, and the other matter in the celestial spaces, are either at rest, or nearly so; as having no motion but what they receive from the sun's circumrotation. Thus are the vapours raised into the tails of comets in the neighbourhood of the sun, where the orbits are most curve; and where the comets being within the denser atmosphere of the sun, have their tails of the greatest length. The tails thus produced, by preserving that motion, and, at the same time, gravitating towards the sun, will move round his body in ellipses, in like manner as their heads; and by this means will ever accompany, and freely adhere to their head. In effect, the gravitation of the vapours towards the sun, will no more occasion the tails of comets to forsake their heads, and fall down towards the sun,

so diverting as to change vortexes. We that never go out of our own sphere, lead but a tiresome life; if the inhabitants of a comet had but the wit to foresee the time when they are to come into our world, they who had already made the voyage, could tell their neighbours beforehand what they would see, and could inform them, that they would discover a planet with a great ring about it, meaning our Saturn; they would also say, you shall see another planet which has four little ones to attend on it; and, perhaps, some of them, resolving to observe the very moment

when the gravitation of their heads will occasion them to fall off from their tails; but by their common gravitation, they will either fall down together to the sun, or be together suspended or retarded. This gravitation, therefore, does not at all hinder, but that the heads and tails of comets, may receive and retain any position towards each other, which either the above-mentioned causes or any other may occasion.

The tails thus produced, when comets are in their perihelion, that is nearest the sun, will go off with their head into remote regions; and, either return thence, together with the comets, after a long series of years; or rather, be there lost, and vanish by little and little, and the comet be left bare; till, at its return, descending towards the sun, some little short tails, be gradually and slowly produced from the heads; which, afterwards, when nearest the sun, descending down into his atmosphere, will be immensely increased.

The vapours, thus rarified, dilated and diffused throughout all the celestial regions, Sir Isaac observes, may probably, by degrees, by means of their own gravity, be attracted down to the planets, and become intermingled with their atmospheres. He adds, that for the conservation of the water, and moisture of the planets, comets

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ment of their entrance into our world, would presently cry out, 'A new sun, a new sun,' as sailors use to cry, 'Land, Land.'

We have no reason then, says I, any longer to pity the inhabitants of a comet; yet I suppose you will think their condition lamentable, who inhabit a vortex whose sun comes in time to be quite extinguished, and consequently who live for ever after in eternal night. How, cried the marchioness, can suns be extinguished? Yes, without doubt, says I; for people some thousand years ago saw fixed stars in the sky, which are now no more to be seen: these were the suns which have lost their light, and certainly there must be a strange desolation in their vortexes, and a general

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rets seem absolutely necessary, from whose condensed vapours and exhalations, all that moisture which is spent in vegetations, and putrefactions, and turned into dry earth, &c. may be supplied and recruited; for all vegetables grow, and increase wholly from fluids; and, again, their greatest part turns, by putrefaction, into earth, an earthy slime being perpetually precipitated to the bottom of putrifying liquors. Hence, he thinks, the quantity of dry earth must continually increase, and the moisture of the globe decrease, and, at last, be quite evaporated, if it have not a continual supply from some part or other of the universe. And, I suspect, adds our great author, that the spirit which makes the finest, subtlest, and best part of our air, and which is absolutely requisite for the life and being of all things, comes principally from the comets. On this principle there seems to be some foundation for the popular opinion of presages from comets, since the tail of a comet, thus intermingled with our atmosphere, may produce changes very sensible in animal and vegetable bodies.

OF

mortality over all the planets; for what can people do without a sun? This is a dismal prospect, says the lady; I would not, if I could help it, let the idea of it come into my head. I will tell you, if you please, replied I, what the opinion of learned astronomers is as to this particular: they think that the fixed stars which have disappeared, are not quite extinguished, but that they are half suns, that is, they have one half dark, and the other half light, and turning round upon their own axis or centre, they sometimes shew us their light side, and afterwards turning to us their dark one, we see them no more. According to all appearances, the fifth moon of Saturn is thus made; for during one part of its revolution, we absolutely lose sight of it, and the reason is not, that it is then farther distant from the earth; on the contrary, it is at some of these times nearer than

Of all the comets, none came so near the earth as that of 1680; for, by calculation, Dr. Halley found that November 11th. about 6 minutes past one of the clock in the afternoon, that comet was not above one semi-diameter of the earth, to the northwards of the way of the earth; at which time, had the earth been in that part of its orbit, the comet would have had a parallax equal to that of the moon: what might have been the consequence of so near an approach, no body knows; some think a shock or contact, Mr. Whiston says a deluge.

Plate IV. fig. 6. is the representation of the lowest part of the tail of a comet, near its perihelion, or approach to the sun, with the purer part of its atmosphere, winding itself into the tail, and the cloudy part of the same placed round about the central solid, as it appeared to Dr. Hook through a telescope.

than it is at others when we see it. And though this moon is not a planet, from which any consequence relative to a sun can be drawn, we may very well imagine a sun, which may, in part, be covered with fixed spots; when, on the contrary, ours hath only moveable temporary ones. To oblige you, madam, I will be of this opinion, because it is not so harsh as the other, though I cannot make it good but in relation to some certain stars, because, as Huygens has lately observed, (9) those stars have their regulated times of appearing, and disappearing, otherwise there could be no such thing as half-suns. But what shall we say of stars, which totally disappear, and never shew themselves again, after they have taken a sufficient time for their course of turning round upon their own axis? You are too just, madam, to oblige me to believe that these stars are half-suns. However, I will try once more what I can do in your favour: these suns are not extinguished,

(9) *Those stars have their regulated times of appearing and disappearing.*] The stars which appear and disappear by turns, being always found to increase in magnitude at their first appearance, and to decrease as they begin to disappear; and being likewise still visible through telescopes, for some time after they are lost to the naked eye, (of which we have various instances in the philosophical transactions) seem to be no more than planets performing their periods about the fixed stars, as their respective suns, which periods are very long, even of more duration than that of Saturn, though perhaps we are not always properly situated to observe their returns.

Kepler,

guished; they are only sunk so low into the immense depth of heaven, that we cannot possibly see them; in this case, the vortex follows its sun, and all is well again. It is true, that the greatest part of the fixed stars have not this motion, by which they remove themselves so far from us, because at other times they might return again nearer us, and we should see them sometimes larger, and sometimes smaller, which never happens. But we will suppose that none but the little, light, and most active vortexes, which slip between the others, make certain voyages, after which they return again, while the main body of vortexes remains unmoved. It is likewise very strange, that some fixed stars shew themselves to us, and take up a great deal of time in appearing and disappearing, and, at last, totally and entirely disappear. Half-suns would appear

Kepler, it is true, denies that each star can have its system of planets as our sun has; and takes them all to be fixed in the same surface or sphere; urging, that were one twice or thrice as remote as another, it would appear twice or thrice as small, supposing their real magnitudes equal; whereas there is no difference in their apparent magnitudes, justly observed, at all. But to this may be answered, that Huygens has not only shown, that fires and flames are visible at distances, where other bodies comprehended under equal angles disappear; but it should likewise seem, that the optic theorem about the apparent diameters of objects being reciprocally proportionable to their distances from the eye, does only hold while the diameter of the object has some sensible proportion to the distance.

Those

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appear again at their fixed and regulated time. But suns, which should be sunk low into the depths of heaven, would disappear but once, and not appear again for a vast space of time.

Now, madam, declare your opinion boldly: must not these stars, of necessity be suns, which are so much darkened as not to be visible to us; yet afterwards re-kindle again, and, at last, become wholly extinct?

How can a sun, says the marchioness, be darkened and quite extinguished, when it is in its own nature a fountain of light? It may be done, madam, says I, with all the ease in the world, if Descartes's opinion be true, that our sun has spots; now, whether these spots be scum, or thick mists, or what you please, they may thicken and unite, till, at last, they cover the sun with a crust which daily grows thicker, and then farewell sun. If the sun is a fire attached to a solid matter, which nourishes it, we are not better off; solid matter will in time be consumed: it is said, we have already had a fine escape; (10) it is reported, that the sun for some whole years together has looked very pale; for example, the year

Those temporary stars, which, upon disappearing, were never found to return again, are probably conjectured to be in the number of the comets, which make long excursions from their suns, or the centres of the upper planetary systems; i. e. from the fixed stars, returning too seldom to have their returns perceived.

(10) *It is reported, that the sun for some whole years together has looked very pale.* See a foregoing note, p. 112.

year after Cæsar's death; it was this crust that then began to grow, but the force of the sun broke through, and it was dissipated; had it continued, we had been all a lost people.

You make me tremble, replied the lady; and now I know the fatal consequences of the sun's paleness, I believe, instead of going every morning to the glass, to see how I look myself, I shall cast my eyes up to heaven, to see whether or no the sun looks pale. O! lady, says I, there is a great deal of time required to ruin a world. I grant it, says she; yet, it may be done at last, nothing but time that is required. I confess it, madam; all this immense mass of matter, which composes the universe, is in perpetual motion, no part of it is excepted; and since every part is moved, you may be sure that changes must happen sooner or later; but still in times proportioned to the effect.

(11) The ancients were pleased to imagine, that the celestial bodies were, in their own nature, unchangeable, because they observed no alteration in them; but they did not live long enough to confirm their opinion by their own experience; they were young philosophers in comparison of us. Give me leave, madam, to explain myself by an allegory: if roses, which last but a day, could write histories, and leave memoirs one to another; and if the first rose should draw an exact

(11) *The ancients were pleased to imagine, &c.* The reader is referred to the foregoing notes on this head, particularly p. 165, & seq.

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act picture of his gardener, and, after fifteen thousand rose-ages, it should be left to other roses, and so on still to those that should succeed, without any change in it; should the roses hereupon say, 'We have seen every day the same gardener, and in the memory of roses, none ever saw any gardener but this; he is still the same he was, and therefore certainly he will not die as we do; for there is no change at all in him.' Would not these roses, madam, talk very foolishly? And yet there would be more reason in their discourse, than there was in what the ancients said concerning the celestial bodies; and though even to this very day there should appear no visible change in the heavens, and the matter of which they are made, should have all the signs of an eternal duration, without any change; yet I would not believe them unchangeable, till I had the experience of many more ages. Ought we, whose lives are but a span long, to make our continuance the mensurate duration of any other being? Shall it be said, that that which hath existed an hundred thousand times longer than we, is to endure for ever? It is not so easy a matter to be eternal: a thing must have lasted many ages of men, one after another, for beginning to give a sign of immortality. Truly, says the marchioness, I find these worlds are far from being able to pretend to it; I will not do them so much honour, as to compare them to the gardener, who lived so much longer than the roses: I begin to think them like the roses themselves, which blow
one

one day in a garden, and die the next : for I understood, that if old stars disappear, new ones come in their room, because every species must preserve itself.

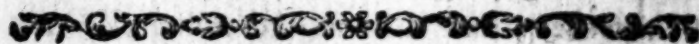
No species, madam, says I, can totally perish ; some, perhaps, will tell you, that such new stars are suns, which return to our sight again, after they have been a long time hid from us, in the profundity of heaven : others may tell you, they are suns, cleared from that thick crust which once covered them : this is possible, yet I likewise believe, that the universe may be framed in such a manner, that, from time to time, it may produce new suns ; why may not that matter which is proper to make a sun, be dispersed here and there, and gather itself again at last into one certain place, and lay the foundation of a new world ? I am very much inclined to believe such new productions, because they suit with that glorious and admirable idea which I have of the works of nature. Can we think, that all-wise nature knows no more, than the secret of making herbs and plants live and die by a continual revolution ?

I am verily persuaded, and are not you so too, madam, that nature, without much cost or pains, can put the same secret in practice upon the worlds ? But we have on this subject more than simple conjectures. The fact is, that after the expiration of near an hundred years, we have seen, with our telescopes, an heaven entirely new, and unknown to the ancients ; there are not many
constel-

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constellations in which some sensible change has not happened; and it is in the milky-way that we have remarked the most; as if in this Ant's nest of worlds, there reigned more motion and restlessness than elsewhere. I now find, says she, the worlds, the heavens and celestial bodies, so subject to change, that I am come to myself again. To recover yourself the better, replied I, let us say no more of these matters. We are arrived at the very upper regions of all the heavens; and to tell you whether there be any stars beyond it, you must have a more able astronomer than I am; you may place worlds there, or not, as you please: it is the philosopher's empire to describe those vast and invisible countries, which are, and are not, or are such as he pleases to make them: it is enough for me to have carried your mind, as far as you can see with your eyes.

Well now, says the marchioness, I have the whole system of the universe in my head; how learned am I become? Indeed, madam, says I, you have had reasoning enough, and with this advantage, either of believing, or disbelieving any thing I have said, but what you may think proper; all the recompence I desire for the pains I have taken, is, 'that you would never look upon 'the sun, the heavens, or the stars, without thinking of me.'



After I had given these conversations to the public, I thought I ought not to conceal any thing from them on this subject. I have published a new conversation, which happened a long time after the others, but which is exactly of the same kind: it bears the name of an Evening one, because the others are so called, and that it seemed much better to give them all the same title.

THE SIXTH EVENING.

*New observations confirming the preceding ones:
And some farther discoveries made in the heavens.*

IT is so long since the marchioness of G*** and I, had any discourse concerning the planetary worlds, that we began even to forget whether we had ever any on that subject. When I went one day to visit her, I came in just as two very polite gentlemen had taken their leaves of her. Well! says she, the very moment she perceived me, you see who have honoured me with a visit; and, I protest, it has given me some room to suspect, that you have imposed upon my judgment. I should be very proud, replied I, if I could flatter myself with such a power over you,
because

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because I look upon it to be the hardest task any one could attempt. As hard as it is, says she, I am afraid you have done it. I do not know how it came about, but our conversation turned upon the plurality of worlds with my two friends who are just gone: I am not certain, but they might have introduced the discourse with a malicious design. I made no scruple to tell them directly, that all the planets were inhabited; one of them replied, he was very well satisfied I did not believe a word of it; and I, with all the simplicity imaginable, maintained, that it was my real opinion; he said, that he still looked upon it as a piece of dissimulation, designed to divert the company: and I have since thought, what made him so positive that I did not believe my own sentiments, was, that he had too high an opinion of me, to conceive that I could entertain so extravagant a notion. As for the other gentleman, who had not altogether that esteem for me, he took me at my word. For God's sake, why did you put a thing in my head, which people that value me cannot think I maintain seriously? Nay, madam, says I, but why would you attempt to maintain any serious position among a set of people, who, I am sure, never entered into a way of reasoning which had the least cast of seriousness? we should not affront the inhabitants of the planets so highly by exposing them to such persons; but content ourselves with being of a little select number of advocates for them, and not communicate our mysteries to the vulgar. How, says the marchioness,

oneſs, do you call my two laſt viſitants the vulgar? They may have wit enough, ſays I, but they never reaſon at all. And your reaſoners, who are a ſevere ſet of people, will not make any difficulty of ſorting them with the vulgar. On the other ſide, theſe men of fire revenge themſelves by ridiculing the reaſoners; and think it is a very juſt principle in nature, that every ſpecies deſpiſes what it wants. It were right, if it was poſſible, to conform ourſelves to every ſpecies; and it had been much better for you, to have railed on the inhabitants of the planets, with your two friends, becauſe they are better at railery than reaſoning, which they never make uſe of: you had then come off with their joint eſteem; and the planets would not have loſt a ſingle inhabitant by it. Would you have had me ſacrifice the truth to a jeſt? ſays ſhe. And is that all the conſcience you have? I own, answered I, that I have no great zeal for theſe kinds of truths, and I will ſacrifice them with all my ſoul to the leaſt conveniencies of ſociety.

For inſtance, I ſee what is, and always will be, the reaſon, why the opinion of the planets being inhabited, is not thought ſo probable as it really is: the planets always preſent themſelves to our view as bodies which emit light; and not at all like great countries, and large meadows. We ſhould readily agree, that plains and meadows were inhabited; but for luminous bodies to be ſo too, there is no ſufficient ground to believe it. Reaſon may come and tell us, over and over,
that

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that there are plains and meadows in these planets ; but reason comes a day too late ; the first glance of our eyes has had its effect upon us before her, we will not hear a word she says, the planets must be only luminous bodies, and what sort of inhabitants should they have, our imagination of course would presently represent their figures to us ? It is what she cannot do, and the shortest way is to believe there are no such beings.

Would you have me, for the establishment of these planetary people, whose interests are far from affecting me, go to attack those formidable powers, called sense and imagination ? it is an enterprize would require a good stock of courage to undertake it, and we cannot easily prevail on men, to substitute their reason in the place of their eyes. I sometimes meet with reasonable people enough, who are willing, after a thousand demonstrations, to believe that the planets are so many earths : but their belief is not such as it would be, if they had not seen them under a different appearance ; they still remembered the first idea they entertained, and they cannot well recover themselves from it. It is this kind of people, who, in believing our opinion, think they do us a courtesy, and only favour it for the sake of a certain pleasure which its singularity gives them.

Well, says the marchioness, interrupting me, and is not this sufficient for an opinion, which is but barely probable ? You would be very much surprized, says I, if I should tell you, probability

is a very modest term. Is it simply probable that there ever was such a man as Alexander the Great? you hold it very certain that there was, and upon what is this certainty founded? because you have all the proofs which you could desire in a like matter? and there does not the least subject for doubt present itself, to suspend or alter your determination; for you never saw this Alexander, and you have not one mathematical demonstration that there ever was such a man. Now, what would you say if the inhabitants of the planets were almost in the very same case? we cannot pretend to make you see them, and you cannot insist upon the demonstration here, as you would in a mathematical question; but you have all the proofs you could desire in such a case. The entire resemblance of the planets with the earth, which is inhabited; the impossibility of conceiving any other use for which they were created; the fecundity, and magnificence of nature; the certain regards she seems to have had to the necessities of their inhabitants, as in giving several moons to those planets remote from the sun, and more moons still to those yet more remote; and, what is still very material, there are many things to be said in favour of one side, and nothing on the other; and you cannot comprehend the least subject for a doubt, unless you will take the eyes and understanding of the vulgar. In short, supposing that these inhabitants of the planets were certainly known to us, they could not declare themselves by more sensible marks; and,
after

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after this, you are to consider whether you are willing not to take their case to be more than purely probable. But you would not have me, says she, look upon this to be as certain as that there was such a man as Alexander? Not altogether, madam, says I; for though we have as many proofs touching the inhabitants of the planets, as we can have in the situation we are, yet the number of these proofs is not very great.

I am going to renounce these planetary inhabitants, says her ladyship, interrupting me; for I cannot conceive how to rank them in my imagination; there is no absolute certainty of them, and yet there is more than a probability; so that I am confounded in my notions. Ah, madam, says I, never put yourself out of conceit with them for that; the most common and ordinary clocks shew the hours; but it is those that are wrought with more art and nicety which shew the minutes. Just so your ordinary capacities are sensible of the difference betwixt a simple probability, and an evident certainty; but it is only your people of superior understanding that can discern the exact proportions of certainty or probability, and can mark, if I may use the phrase, the minutes in their sentiments. Now place the inhabitants of the planets a little below Alexander, yet above many other historical facts which are not so clearly proved; I believe this situation will do.

I love order, says she, and you oblige me in thus ranging my ideas for me: but pray, why did

did not you take this care before ? Because, says I, should you credit the inhabitants of the planets either a little more or less than they deserve, there will be no great damage in it. I am sure that you do not believe the motion of the earth so fully as it ought to be believed ; and have you much reason to complain on that score ?

O ! for that matter, replied she, I have discharged myself very well, you have nothing to reproach me with on that account, for I firmly believe that the earth turns. And yet, says I, madam, I have not given you the strongest reasons in proving it. Ah ! traitor, she cried, this is deceiving me, to make me believe things upon feeble proofs : then you did not think me worthy of believing upon substantial reasons ? I only proved things, says I, upon little plausible reasons, and such as were adapted to your peculiar use : should I have conjured up as strong and solid arguments, as if I had been to attack a doctor in the science ? Yes, says she ; pray take me for a doctor from this moment, and let me have your full demonstrations of the earth's motion.

With all my heart, says I, madam, and I own the proof pleases me greatly, perhaps, because I think it was my own discovery ; yet it is so just and natural, that I must not presume positively to have been the inventor of it : it is most certain, that if a learned man was desired to make replications to it, he would be obliged to declaim at large, which is the only method in the world to

confound

confound a learned man. (1) We must grant, that either all the celestial bodies, in twenty-four hours, turn round the earth, or that the earth, turning on itself, makes us attribute its motion to all the celestial bodies. But that they really have this revolution in twenty-four hours round the earth, is a matter which has not the least probability in the world, though the absurdity does not presently appear to our view. All the planets certainly make their great revolution about the sun; but these revolutions of theirs are unequal, according to the distances of the respective planets from the sun; for the most remote ones make their course in a longer time, which is most agreeable to nature: the same order is observed among the little secondary planets in turning about a great one. The four moons

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of

(1) *We must grant, that either all the celestial bodies, in twenty-four hours, turn round the earth.*] We have, in the course of the foregoing notes, shewn many reasons why the Ptolemaic system is incompatible with the appearances of the heavenly bodies. For the sake of such of our readers as may be unacquainted with it, we will inform them, that, by this system, the earth and waters are supposed to be in the centre of the universe; next to them, is the element of air, and next above that is the element of fire; next that the orb of Mercury, then that of Venus, next that of the sun; and above the sun's orb, those of Mars, Jupiter, and Saturn; and above them all, the firmament or orb of the fixed stars; then the chrystalline orbs, and, lastly, the *Coelum Empyreum*, or *Heaven of Heavens*. All those massy orbs, and vast bodies born by them, are, in this system, supposed to move round the earth once in twenty-four hours;

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of Jupiter, and the five of Saturn, make their
circles in more or less time round their respective
primary planets, according as they are more or
less remote. Besides, it is certain, that the pla-
nets have motions upon their own centres, and
these motions likewise are unequal; we cannot
well tell how to account for this inequality, whe-
ther it proceeds from the different magnitudes of
the planets, or to their different solidities, or to
the different swiftness of the particular vortexes
which inclose them, and the liquid matter in
which they are sustained; but, in short, the in-
equality is most undoubted; and such is the or-
der of nature in general, that whatever is com-
mon to many things, is found, at the same time,
to vary in some different particulars.

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hours; and besides that, in some other certain periodical
times. For the effecting of which motions, the antients were
forced to contrive such circles as they called excentrics
and epicycles, crossing one another with great perplexity
and confusion. And this system is universally maintain-
ed by the peripatetick philosophers, who have still many
followers in Spain, Italy, and other countries, where ig-
norance in more material matters also prevails. The ce-
lebrated Galileo, for not giving absolute credit to this
hypothesis, and for embracing the Copernican system,
was (by the ill-will and instigation of Pope URBAN VIII,
as it is supposed) sent to the prison of the Inquisition,
fell under the censure of that tribunal, had his *Coperni-
can Tenets* condemned by them, and was forced to ab-
jure them. The particulars of which, if the reader
has a mind to see, he may find in *Riccioli's Almagest*,
lib. 9. sect. 4. cap. 40. We have given a representati-
on of the Ptolemaic system, Plate II. fig. 2.

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I understand you, says the marchioness, interrupting me, and I think, there is a great deal of reason in what you say; I am entirely of your mind; if the planets turned about the earth, they would do it in unequal spaces of time, according to their distances, as they do about the sun; is not that the meaning of what you were saying? Exactly, madam, says I, their unequal distances, with respect to the earth, their different solidities, and the different rapidity of the particular vortexes inclosing them, should consequently produce differences in their pretended motion round the earth, as well as in all their other motions. And as to the fixed stars, which are at such a prodigious distance from us, and so much elevated above every thing that can take a general motion round us, at least they are situated in a place where this motion must be very weak; is there not a very great probability, that they do not turn at all about us in twenty-four hours, as the moon seems to do, which is so near us? And should not comets, which are strangers in our vortex, and which run courses so different one from the other, and with such unequal rapidity, be excused from turning round us in the same space of twenty-four hours? But no matter, planets, fixed stars, and comets, all are made to turn round the earth in twenty-four hours; yet, if there were some minutes difference in these motions, we might be contented; and yet they all must make them with the most exact equality, or rather the only exact equality which

is in the world, and not one minute more or less must be allowed. In reality, this matter is strangely to be suspected.

O, says the lady, it is possible that this grand equality only exists in our imagination, I am entirely convinced it is derived only from thence. I am very well pleased, that any position, which is against the genius of nature, should fall entirely upon ourselves, and that she should stand discharged, though at our expence. For my part, says I, I am such a foe to a perfect equality, that I cannot even allow all the turns, which the earth every day makes on herself, should be precisely in twenty-four hours, and always equal one to another; I should be very much inclined to think that there are variations. Variations! cried the lady, why (2) do not our pendulums mark an entire equality? O, says I, to your pendulums

(2) *Do not our pendulums mark an entire equality.* The inequality of time is thus accounted for: the natural or solar day is measured, not properly by one entire revolution of the earth in twenty-four hours; but by the time which passes while the plane of our meridian, passing through the centre of the sun, does, by the earth's rotation round its axis, return again to the sun's centre; which is the time between our mid-day and the next. Now, had the earth no other motion but that round its axis, all the days would be precisely equal to each other, and to the time of the earth's revolution. [Note, both day and night are here understood, or twenty-four hours to be comprehended in a day.] But the case is otherwise; for while the earth is turning round its axis, it is likewise proceeding forward in its orbit; so that when a meridian is completing a whole revolution from the sun's

dulums I must object, for they cannot be altogether just; and sometimes when they shew us that one circuit of twenty-four hours, is longer or shorter than another, we should rather be inclined to believe them irregular, than to suspect the earth of any irregularity in her revolutions. What a complaisant respect is this we have for her! I would no more depend on the earth, than on a pendulum; and the very same casualties almost, which will disorder the one, will make the other irregular; only, I believe, there must be more time allowed for the earth, than a pendulum, to be visibly put out of order; and that is all the advantage we can give on her side. But might she not, by degrees, draw nearer to the sun? And there finding herself in a situation, where the matter is more agitated, and the motion more rapid, she would, in less time, make a double re-

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volution

sun's centre, its plane is not yet arrived at the sun's centre again. Hence it appears, that the solar days are all longer than the time of one revolution of the earth round its axis. However, if the earth proceeded in its orbit with an equable motion, all the solar days would equal each other, and the real and apparent time would agree, but this is not the case; for the earth does not proceed in its orbit with an equable motion, but at its greatest distance from the sun describes a less arch, and at its nearest distance a greater one: (for its orbit is not a circle but an ellipsis) beside, the planes of the meridians are not perpendicular to the ecliptic, but to the æquator; consequently, the time of the diurnal revolution, or from one meridian's opposition to the sun until it arrives to it again, is not always of the same quantity. The same thing will hold true, if, instead of the earth's motion,

volution both about the sun and herself; consequently her years and days will be shortened, but not to be perceived, because we must still go on to divide the year into three hundred and sixty-five days, and the days into twenty-four hours: so that, without living longer than we now do, we shall live more years; and, on the other hand, if the earth withdraws from the sun, men may live fewer years than we do now, and yet have lives of the same extent as ours. There is a great deal of probability, says she, that whenever it falls out thus, long successions of ages will make but a very little variation. I agree with you, madam, replied I, the conduct of nature is very nice, and she has a method of bringing about all things by degrees, which are not sensible, but in very obvious and easy changes; we are scarce able to perceive the change of the seasons; and for some others that are made remarkably slow, they

motion, we consider the apparent one of the sun in lieu thereof, as being what we measure time by. On this principle we observe, that the day not only includes the time of one turn of the globe on its axis, but is increased by so much as answers to that part of the sun's motion performed in that time: for when that part of the equinoctial, which, with the sun, was at the meridian yesterday at noon, is come thither again to day, it is not yet noon; the sun not being now at the place that he yesterday was, but gone forward, near a degree more or less. And this addition above the twenty-four equinoctial hours is upon a double account unequal. First, because the sun being nearer to, or farther from, the earth at different times of the year, does not go through an equal part of the ecliptic in one day, but more in December

they do not fail to escape our observance. However, all is in a perpetual rotation, and consequently the whole undergoes some change; and (3) the lady's face in the moon, which was discovered with telescopes, within these forty years, is grown considerably old. She had a good tolerable countenance; but now her cheeks are sunk, her nose is grown long, and her chin and forehead meet; so that all her graces are vanished, and age has made her a terrible spectacle.

What a story do you tell, says the lady, interrupting me! It is only a piece of drollery, madam, replied I; they have perceived in the moon a particular figure, which had the air of a woman's head jutting out of rocks, and it is owing to some changes that have happened there. Some pieces of mountains have mouldered away, and left us to discover three points, which can only serve to make up the forehead, nose and chin, of

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an

ember than in June. Secondly, though he even should do so, yet equal parts of the ecliptic do not in all parts of the circle answer to equal parts of the equator, because some parts thereof, near the summer and winter solstices, lie nearly more parallel to the equinoctial than others, as may be seen in a common map of the earth. The apparent motion of the sun to the east then being unequal, the natural and apparent days are no ways proper to be applied to measure the celestial motions, which have no dependance on the sun. Hence astronomers have invented others for the use of their calculations; and on this account tables of equation have been formed.

(3) *The lady's face in the moon is grown considerably old.* What our author has affirmed, concerning those changes

an old woman. Well, says she, but do not you think some malicious destiny had a particular spite to beauty, to make choice of this female-head, to attack above all the rest of the moon? Perhaps, in recompence, replied I, the changes which happen upon our earth, dress out some face, which the people in the moon see; I mean something like what we conceive to be a face in the moon; for every one bestows on objects those ideas of which they themselves are full. Our astronomers see, in the surface of the moon, the faces of women; it may be, that the ladies there make their speculations, and discern the physiognomy of fine men in our earth. For my part, madam, I do not know whether I should not fancy your ladyship's charms there. I protest, says she, I could not help being obliged to any one who should find me there. But to come back to what you were mentioning just now; do
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changes in the face of the moon, is not to be absolutely depended upon; yet M. Bianchini, in the *Memoires de Trevous* for June 1729, relates, that on the 25th of August 1725, they discovered in her at Rome, in the presence of cardinal Polignac, a new and very considerable brightness in that part, which they called Plato; (for, in honour of the great philosophers, astronomers thought fit to give their names to divers countries of the moon, as Fontenelle has before observed) they also saw the same illumination in this planet September 22, 1727. It seemed to possess the 33d part of the diameter of the moon. See *Observations de la Planete de Venus, par M. Bianchini*. [*Mem. de Trev. p. 1039. 1040. Juin.*]

Our author has all along followed the opinion, of Mr. Huygens, who, in his *Cosmotheoreos*, p. 115. concludes
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any considerable changes affect the earth? In all appearance they do, replied I; several very high mountains, which are far distant from the sea, have great beds of shells, which seem absolutely to shew that the water hath formerly covered them. Sometimes, farther yet from the sea, they find stones, in which are petrified fishes. Who could have put them there, if the sea had not been there? Old fables tell us, that Hercules split asunder with his hands, the two mountains, called Calpe and Abila, which stood betwixt Afric and Spain, and stopped the ocean from flowing there; and that immediately the sea rushed with violence over the land, and made that great gulph which we call the Mediterranean. Now, this is not intirely fabulous, but a history of those re-

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the moon to have no atmosphere, because we see its limb so clearly and accurately defined, and because he thought there were no seas nor rivers in the moon. But he, as well as Fontenelle, were mistaken in regard to the conclusion, and part of their premisses; for in the solar eclipse, May 1, 1706, which, in Switzerland, was total, they could manifestly perceive the moon's atmosphere, as may be seen in the accounts given in the *Philosophical Transactions*, No. 306. And since that, in the eclipse of the sun, April 22, 1715, the moon's atmosphere was very discernible, appearing in the form of a curious ring of vapours, encompassing the moon all the time of total darkness; of which see the accounts in the *Philosophical Transactions*, and Mr. Whiston's. If this be true, that she has an atmosphere, we need seek no farther for such changes on her surface as our author mentions; for vapours, though extremely rare, will reflect light at immense distances. Witness our *Aurora Borealis*, through which the stars are commonly seen.

mote times, which has been disguised, either from the ignorance of the people, or through a love they had for the marvellous, two of the most ancient frailties of mankind. That Hercules should separate two mountains, with his hands, is absolutely incredible; but that in the time of one Hercules, or another, for there were fifty of that name, the ocean might have forced down two mountains, not so strong as others in the world, perhaps through the assistance of some earthquake, and so take its course betwixt Europe and Afric, gives me no manner of pain to believe. What a notable spot might the lunar inhabitants, all of a sudden, then discover on our earth; for you know, madam, that the seas are spots. It is no less than the common opinion, that Sicily was separated from Italy, and Cyprus from Syria: there are sometimes new islands formed in the sea: earthquakes have swallowed up mountains, others have rose and altered the course of rivers. The philosophers give us apprehensions, that the kingdoms of Naples and Sicily, which are countries founded upon great subterranean vaults, full of sulphur, that will in time be consumed, will one day sink in, when those vaults shall no longer be able to resist the flames which they contain, and which, at this time, exhale at those vent-holes the mouths of Vesuvius and Ætna. Is there not here causes enough to diversify the prospect which we afford to the people in the moon?

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we see it night and morning, except at these times that it cannot, as I but now observed, disengage itself from the twilights, which are too strong and lasting for it to appear; for we suppose it to be a continued light, and in all probability it is so. We have begun to conjecture, that it is produced from some prodigious quantity of matter crouded together, which surrounds the sun to a certain extent from it: the greater part of his rays pierce through this matter which surrounds it, and come down to us in right lines; but there are some, which, in passing from the sun, strike against the internal surface of this matter, and are by it reflected towards us, and arrive at our globe in the morning, before the direct rays can reach us, and in the evening, after we are out of the reach of the sun's direct rays. Now, as these reflected rays come from a greater height than those which are direct, we must consequently have them sooner, and keep them longer.

On this account, I must retract what I have already mentioned, that the moon must have no twilight for want of being surrounded by such a gross air as the earth. But she can be no loser; her twilights will proceed from that kind of gross air which surrounds the sun, and reflects his rays on places which his direct ones cannot reach. But pray, let me know, says the marchioness, are not there twilights formed thus for all the planets, who will not need every one to be clothed with a distinct gross air, because that which
surrounds

surrounds the sun alone, may have one general effect for all the planets in the vortex? I am mighty willing to think, that nature, agreeable to that inclination which I know she has to œconomy, and good management, should make that single means alone answer her purpose: yet, replied I, notwithstanding this supposed œconomy, she has given, with respect to our earth, two causes for twilight; one whereof, which is the thick air about the sun, would be wholly useless, and can only be an object of curiosity for the students of the observatory; but it is possible, that only the earth may send out from herself vapours and exhalations gross enough to produce twilights, and that nature had reason to provide, by one general means, for the necessities of all the other planets, whose substance may be of a purer mould, and their evaporations consequently more subtle. We are, perhaps, among all the inhabitants of the worlds in our vortex, the only persons who required to have a more gross and thick air given us to breathe in. With what contempt would the inhabitants of the other planets consider us, if they knew this?

They would be out in their reasoning, says the marchioness, we are not to be despised for being enveloped with a thick air, since the sun himself is so surrounded. Pray, tell me, is not this air produced by certain vapours, which you have before told me issued from the sun; and does it not serve to break the first force of his rays, which had else probably been too bright? I conceive

ceive, that the sun may be veiled by nature, to be in a better manner adapted to our use. Well, madam, replied I, this is some small introduction to a system which you have very happily started. We may add, that these vapours produce a kind of rain, which falling back upon the sun, may cool and refresh it, as we sometimes throw water into a forge, when the fire is too fierce. There is not any thing but what we may imagine from nature's address; but she has another kind of address very particular, which is to conceal herself from us, and we should not willingly be too confident, that we have found out her method of acting, or her designs in it: in case of making new discoveries, we should not be too importunate in our reasonings, though we are always fond enough to do it; and your true philosophers are like elephants, who, as they go, never put their second foot to the ground, till their first be well fixed. The comparison seems more rational to me, says she, than the merit of those two species of animals, elephants and philosophers, no way consisting in exterior agreements. I am willing to imitate the judgment of both; now teach me some of the latter discoveries, and I promise you not to make any rash systems.

I have told you, madam, replied I, all the news I know from the firmament, and, I believe, the freshest advices you can have. I am sorry, they are not as surprizing and wonderful, as some observations which I read the other day, in an abridgment of the Chinese annals, written in latin.

in latin. (6) Those people see thousands of stars at a time, fall from the sky into the sea, with a prodigious noise, or are dissolved, and melt into rains; and these are things which have been seen more than once in China. This observation is made at two several periods, pretty distant from each other; they then go eastward, and burst like a gun, always with a great noise. It is great pity that these kinds of phænomena should be reserved for China only, and that our part of the globe should

(6) *Those people see thousands of stars fall into the sea.*] These could be no real stars, but meteors generated in our atmosphere. Descartes has wrote an express treatise on the formation of meteors. Aristotle and Gassendus have also treated of the same subject. Dr. Woodward's opinion is, that the matter of meteors is of a mineral nature; that the mineral particles contained in the strata of the earth, are raised by the subterraneous heat, together with the vapours ascending from the abyss, and pervading those strata; especially at such times as the sun's heat is sufficient to penetrate the exterior parts of the earth, and to make room for their escape into the atmosphere. Thus sulphureous, nitrous, and other active, and volatile mineral particles, form various meteors, according to the various fate they meet with in the air. Hence balls of fire, lightning, thunder, &c.

Concerning the action of the air in the bowels of the earth, Boerhaave has the following remark. Chymists, says he, will, perhaps wonder, to hear me alledge, that air is necessary in the œconomy of fossils, whose great simplicity of matter, seems only to require the action of fire to enable them to act, or undergo every thing that belongs to this species of things; but the skilful inquirers into nature have long ago discovered, that fossils, even in the deepest mines, generate, multiply, and are driven upwards; all which is performed by some peculiar

should never have their share of these sights. It is not long since all our philosophers were of opinion, that they might affirm on good grounds, that the heavens, and all the celestial bodies, were incorruptible, and therefore incapable of change; and yet, at the same time, there were some men in the other part of the earth, who saw the stars dissolve by thousands, which must produce a very different opinion. But, says the marchioness, have we not always heard that the Chinese were great astronomers? It is true, says I; but the Chinese

peculiar power of the subterraneous fire; but then, it is also evident, that the subterraneous fire, as perpetual as it is, is only retained, collected and applied, in such places, by means of the air

Our atmosphere may properly be considered as an universal chaos, consisting of almost all kinds of corpuscles, confusedly jumbled together, and constituting one mass; so that there is, perhaps, not a more heterogeneous body in the world.

The phlogistic or inflammable principle, of which, with the vitriolic acid, sulphur is formed, may be, and is exalted into the air, in sufficient quantities to form sulphur in our atmosphere; witness the sulphurous smell, that remains upon bodies struck with lightning. Sulphur contains, according to the chymists, not more than a sixteenth part of this inflammable principle to fifteen of the corrosive vitriolic acid, which acid is raised from the earth, in great quantities, into the atmosphere, not by the subterraneous heat alone, but it is also volatilized by the action of the air; for in extracting this acid from mineral bodies by vehemence of heat, it is well known to chymists, that if the least crack or fissure be in the vessels, so as to admit air, that, instead of an heavy concentrated acid, not exhaleable in the air, an extremely volatile liquor is produced, emitting pungent and almost suffocating vapours

Chinese have the same advantage from being divided from us, by such a prodigious tract of earth, as the Greeks and Romans, by being so much prior to us by a long course of ages. Distances of every sort pretend a right of imposing on us. In reality, I think still more and more, that there is a certain genius which has never yet been out of the limits of Europe, or, at least, not much beyond them ; perhaps, he may not be permitted to

pours into the air ; and which will totally arise in distillation, with an heat scarcely too hot for the hand to bear.

Hoffman and others make no question but that sulphur exists in the air ; and that from hence, thunder, lightning, and other fiery meteors are produced ; the vitriolic acid and the inflammable principle, the ingredients with which art can produce sulphur, are unquestionably diffused through the atmosphere. However, we must acknowledge that art cannot produce sulphur but from the strong concentrated acid ; and how infinitely, on the other hand, is the aerial acid divided and diluted. Besides, sulphur cannot be produced by art without fire ; but if we reflect, that nature every day forms substances without the assistance of chemical furnaces, which art cannot do, and operates upon matter quite in another manner than we can have any conception of, it is no wonder therefore, that sulphur, or at least the principles of it, are found in the atmosphere, which are united, and perhaps formed into sulphur, by the electrical fire, the moment the lightning happens.

Others object, that the effects of sulphur and of lightning, are by no means similar ; this we grant ; but if the effects of lightning and gun-powder be compared, a great similarity between them will be observed. And that nitre abounds in our atmosphere (a principal ingredient in gun-powder) is notorious, as all animal and vegetable substances contribute to the production of nitre, so far as they are susceptible of putrefaction. Nitre is dissipated from

to spread over any great extent of the earth at once, and that some fatality prescribes him very narrow bounds. Let us enjoy him whilst we have him; the best of it is, he is not linked to the sciences and dry speculations, but launches out with as much success into subjects of pleasure, in which point I question whether any people equal us. (7) These are such topics, madam, as ought to employ you and give you entertainment; and

from earthy substances impregnated with it, by the sun's heat; hence nitre works are made to face the north, and the largest quantities of nitre are found on the north sides of walls; therefore it may exist in the air. Besides, there is another principle existing in the atmosphere, which greatly contributes to form these meteors; I mean the electrical fire, which is probably the cause of the air's elasticity, from which property of the air all its effects, performed either by lightning or gun-powder, are deducible.

(7) *These are such topics, madam, as ought to employ you.*] The topics which ought to employ, according to our author, the marchioness, give her entertainment, and complete her whole system of philosophy; arise from our superior advantage, in being born in a part of the globe, where not only the true knowledge of nature is cultivated, but also other subjects of more import to mankind are revealed.

While Galileo lifts his tube, and discovers the prodigious magnitude of those radiant orbs, that adorn the heavens; while Newton measures their amazing distances, and unites the whole system, in harmonious order, by the subtle influences of attraction; let us not stop here, by barely admiring the heavens, or the genius and penetration of those who have explored their order and harmony to us; but let us proceed to admire the magnificent scene, not only with an eye of reason, but also with one of devotion; and as we have, with the one, traced

and which should complete your whole system of philosophy.

ced an infinity of worlds; let us, with the other, keep their great creator in our view, and join with the royal Psalmist in that solemn hymn, so suitable to this divine occasion, that I cannot forbear closing these notes with it, as it has been transferred into our language, by one of the highest and happiest efforts of the celebrated Mr. Addison.

I.

*The spacious firmament on high,
With all the blue ethereal sky,
And spangled heav'ns, a shining frame,
Their great original proclaim:
Th' unwearied sun, from day to day,
Does his creator's pow'r display,
And publishes to every land,
The work of an almighty hand.*

II.

*Soon as the evening shades prevail,
The moon takes up the wondrous tale,
And, nightly, to the listning earth,
Repeats the story of her birth:
Whilst all the stars that round her burn,
And all the planets in their turn,
Confirm the tidings as they roll,
And spread the truth from pole to pole.*

III.

*What though, in solemn silence, all
Move round the dark terrestrial ball:
What tho' nor real voice nor sound
Amid their radiant orbs be found?
In reason's ear they all rejoice,
And utter forth a glorious voice,
For ever singing, as they shine,
"The hand that made us is divine."*

Instead of Mr. Addison's oration, in defence of the new philosophy, spoken in the theatre at Oxford, July 7, 1693, which was printed at the end of the old translation of this work; it was thought more adviseable to add the two following Spectators of his on the same subject; as being more pertinent to Fontenelle's design, and more fully explaining the usefulness of this kind of reading, than the abovementioned juvenile performance.

SPECTATOR, No. 420.

—*Quocumque volunt mentem Auditoris agunto.* Hor.

AS the writers in poetry and fiction borrow their several materials from outward objects, and join them together at their own pleasure, there are others who are obliged to follow nature more closely, and to take entire scenes out of her. Such are historians, natural philosophers, travellers, geographers, and, in a word, all who describe visible objects of a real existence.

It is the most agreeable talent of an historian, to be able to draw up his armies and fight his battles in proper expressions, to set before our eyes the divisions, cabals and jealousies of great men, and to lead us step by step into the several actions and events of his history. We love to see the subject unfolding itself by just degrees, and
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breaking upon us insensibly, that so we may be kept in a pleasing suspence, and have time given us to raise our expectations, and to side with one of the parties concerned in the relation. I confess this shews more the art than the veracity of the historian, but I am only to speak of him as he is qualified to please the imagination. And in this respect Livy has, perhaps, excelled all who ever went before him, or have written since his time. He describes every thing in so lively a manner, that his whole history is an admirable picture, and touches on such proper circumstances in every story, that his reader becomes a kind of spectator, and feels in himself all the variety of passions which are correspondent to the several parts of the relation.

But among this sett of writers there are none who more gratify and enlarge the imagination, than the authors of the new philosophy, whether we consider their theories of the earth or heavens, the discoveries they have made by glasses, or any other of their contemplations on nature. We are not a little pleased to find every green leaf swarm with millions of animals, that at their largest growth are not visible to the naked eye. There is something very engaging to the fancy, as well as to our reason, in the treatises of metals, minerals, plants and meteors. But when we survey the whole earth at once, and the several planets that lye within its neighbourhood, we are filled with a pleasing astonishment, to see so many worlds hanging one above another, and
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sliding round their axles in such an amazing pomp and solemnity. If, after this, we contemplate those wide fields of æther, that reach in height as far as from Saturn to the fixt stars, and run abroad almost to an infinitude, our imagination finds its capacity filled with so immense a prospect, as puts it self upon the stretch to comprehend it. But if we yet rise higher, and consider the fixt stars as so many vast oceans of flame, that are each of them attended with a different set of planets, and still discover new firmaments and new lights that are sunk farther in those unfathomable depths of æther, so as not to be seen by the strongest of our telescopes, we are lost in such a labyrinth of suns and worlds, and confounded with the immensity and magnificence of nature.

Nothing is more pleasant to the fancy, than to enlarge it self by degrees, in its contemplation of the various proportions which its several objects bear to each other, when it compares the body of man to the bulk of the whole earth, the earth to the circle it describes round the sun, that circle to the sphere of the fixt stars, the sphere of the fixt stars to the circuit of the whole creation, the whole creation it self to the infinite space that is every where diffused about it; or when the imagination works downward, and considers the bulk of a human body, in respect of an animal an hundred times less than a mite, the particular limbs of such an animal, the different springs which actuate the limbs, the spirits which set these springs a going, and the proportionable minuteness

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of these several parts, before they have arrived at their full growth and perfection. But if, after all this, we take the least particle of these animal spirits, and consider its capacity of being wrought into a world, that shall contain within those narrow dimensions a heaven and earth, stars and planets, and every different species of living creatures, in the same analogy and proportion they bear to each other in our own universe; such a speculation, by reason of its nicety, appears ridiculous to those who have not turned their thoughts that way, though at the same time it is founded on no less than the evidence of a demonstration. Nay, we might yet carry it farther, and discover in the smallest particle of this little world a new inexhausted fund of matter, capable of being spun out into another universe.

I have dwelt the longer on this subject, because I think it may shew us the proper limits, as well as the defectiveness, of our imagination; how it is confined to a very small quantity of space, and immediately stopt in its operations, when it endeavours to take in any thing that is very great, or very little. Let a man try to conceive the different bulk of an animal, which is twenty, from another which is a hundred times less than a mite, or to compare, in his thoughts, a length of a thousand diameters of the earth, with that of a million, and he will quickly find that he has no different measures in his mind, adjusted to such extraordinary degrees of grandeur or minuteness. The understanding, indeed, opens an infinite space

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on every side of us, but the imagination, after a few faint efforts, is immediately at a stand, and finds her self swallowed up in the immensity of the void that surrounds it: our reason can pursue a particle of matter through an infinite variety of divisions, but the fancy soon loses sight of it, and feels in it self a kind of chasm, that wants to be filled with matter of a more sensible bulk. We can neither widen, nor contract the faculty to the dimensions of either extreme. The object is too big for our capacity, when we would comprehend the circumference of a world, and dwindles into nothing, when we endeavour after the idea of an atom.

It is possible this defect of imagination may not be in the soul it self, but as it acts in conjunction with the body. Perhaps there may not be room in the brain for such a variety of impressions, or the animal spirits may be incapable of figuring them in such a manner, as is necessary to excite so very large or very minute ideas. However it be, we may well suppose that beings of a higher nature very much excel us in this respect, as it is probable the soul of man will be infinitely more perfect hereafter in this faculty, as well as in all the rest; insomuch that, perhaps, the imagination will be able to keep pace with the understanding, and to form in it self distinct ideas of all the different modes and quantities of space.

No. 565.

Friday, July 9.

——— *Deum namque ire per omnes
Terrasque, tractusque maris, cælumque profundum.*
Virg.

I Was yesterday about sun-set walking in the open fields, 'till the night insensibly fell upon me: I at first amused myself with all the richness and variety of colours, which appeared in the western parts of heaven: in proportion as they faded away and went out, several stars and planets appeared one after another, 'till the whole firmament was in a glow. The blueness of the æther was exceedingly heightened and enlivened by the season of the year, and by the rays of all those luminaries that passed through it. The galaxy appeared in its most beautiful white. To complete the scene, the full moon rose at length in that clouded majesty, which Milton takes notice of, and opened to the eye, a new picture of nature, which was more finely shaded, and disposed among softer lights, than that which the sun had before discovered to us.

As I was surveying the moon walking in her brightness and taking her progress among the constellations, a thought rose in me which I believe very often perplexes and disturbs men of serious
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and contemplative natures. David himself fell into it in that reflection, ‘ When I consider the heavens the work of thy fingers, the moon and the stars which thou hast ordained, what is man that thou art mindful of him, and the son of man that thou regardest him !’ In the same manner when I considered that infinite host of stars, or, to speak more philosophically, of suns, which were then shining upon me, with those innumerable sets of planets or worlds, which were moving round their respective suns ; when I still enlarged the idea, and supposed another heaven of suns and worlds rising still above this which we discovered, and these still enlightned by a superior firmament of luminaries, which are planted at so great a distance, that they may appear to the inhabitants of the former as the stars do to us. In short, whilst I pursued this thought, I could not but reflect on that little insignificant figure which I my self bore amidst the immensity of God’s works.

Were the sun, which enlightens this part of the creation, with all the host of planetary worlds that move about him, utterly extinguished and annihilated ; they would not be missed more than a grain of sand upon the sea-shore. The space they possess is so exceedingly little in comparison of the whole, that it would scarce make a blank in the creation. The chasm would be imperceptible to an eye, that could take in the whole compass of nature, and pass from one end of the crea-

tion to the other ; as it is possible there may be such a sense in our selves hereafter, or in creatures which are at present more exalted than our selves. We see many stars by the help of glasses, which we do not discover with our naked eyes ; and the finer our telescopes are, the more still are our discoveries. Huygenius carries this thought so far, that he does not think it impossible there may be stars whose light is not yet travelled down to us, since their first creation. There is no question but the universe has certain bounds set to it ; but when we consider that it is the work of infinite power, prompted by infinite goodness, with an infinite space to exert it self in, how can our imagination set any bounds to it ?

To return therefore to my first thought, I could not but look upon myself with secret horror, as a being that was not worth the smallest regard of one who had so great a work under his care and superintendency. I was afraid of being overlooked amidst the immensity of nature, and lost among that infinite variety of creatures, which in all probability swarm through all these immeasurable regions of matter.

In order to recover myself from this mortifying thought, I considered that it took its rise from those narrow conceptions, which we are apt to entertain of the divine nature. We our selves cannot attend to many different objects at the same time. If we are careful to inspect some things, we must of course neglect others. This imperfection which we observe in our selves, is an imperfection

perfection that cleaves in some degree to creatures of the highest capacities, as they are creatures, that is, beings of finite and limited natures. The presence of every created being is confined to a certain measure of space, and consequently his observation is stinted to a certain number of objects. The sphere in which we move and act, and understand, is of a wider circumference to one creature than another, according as we rise one above another in the scale of existence. But the widest of these our spheres has its circumference. When therefore we reflect on the divine nature, we are so used and accustomed to this imperfection in ourselves, that we cannot forbear in some measure ascribing it to him in whom there is no shadow of imperfection. Our reason indeed assures us that his attributes are infinite, but the poorness of our conceptions is such, that it cannot forbear setting bounds to every thing it contemplates, till our reason comes again to our succour, and throws down all those little prejudices which rise in us unawares, and are natural to the mind of man.

We shall therefore utterly extinguish this melancholy thought, of our being overlooked by our maker in the multiplicity of his works, and the infinity of those objects among which he seems to be incessantly employed, if we consider, in the first place, that he is omnipresent; and, in the second, that he is omniscient.

If we consider him in his omnipresence: his being passes through, actuates, and supports the whole

whole frame of nature. His creation, and every part of it, is full of him. There is nothing he has made, that is either so distant, so little, or so inconsiderable, which he does not essentially inhabit. His substance is within the substance of every being, whether material or immaterial, and as intimately present to it, as that being is to it self. It would be an imperfection in himself, were he able to remove out of one place into another, or to withdraw himself from any thing he has created, or from any part of that space which is diffused and spread abroad to infinity. In short to speak of him in the language of the old philosopher, he is a being whose centre is every where, and his circumference no where.

In the second place, he is omniscient as well as omnipresent. His omniscience indeed necessarily and naturally flows from his omnipresence; he cannot but be conscious of every motion that arises in the whole material world, which he thus essentially pervades, and of every thought that is stirring in the intellectual world, to every part of which he is thus intimately united. Several moralists have considered the creation as the temple of God, which he has built with his own hands, and which is filled with his presence. Others have considered infinite space as the receptacle, or rather the habitation of the Almighty: but the noblest and most exalted way of considering this infinite space is that of Sir Isaac Newton, who calls it the sensorium of the Godhead. Brutes and
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men have their *sensoriola*, or little *sensoriums*, by which they apprehend the presence and perceive the actions of a few objects, that lie contiguous to them. Their knowledge and observation turns within a very narrow circle. But as God almighty cannot but perceive and know every thing in which he resides, infinite space gives room to infinite knowledge, and is, as it were, an organ to omniscience.

Were the soul separate from the body, and with one glance of thought should start beyond the bounds of the creation, should it for millions of years continue its progress, through infinite space with the same activity, it would still find it self within the embrace of its creator, and encompassed round with the immensity of the Godhead. Whilst we are in the body he is not less present with us, because he is concealed from us. 'O that I knew where I might find him, says Job. Behold I go forward, but he is not there; and backward, but I cannot perceive him. On the left hand, where he does work, but I cannot behold him: he hideth himself on the right hand that I cannot see him.' In short, reason as well as revelation assures us, that he cannot be absent from us, notwithstanding he is undiscovered by us.

In this consideration of God almighty's omnipresence and omniscience every uncomfortable thought vanishes. He cannot but regard every thing that has being, especially such of his creatures

tures who fear they are not regarded by him. He is privy to all their thoughts, and to that anxiety of heart in particular, which is apt to trouble them on this occasion: for, as it is impossible he should overlook any of his creatures, so we may be confident that he regards, with an eye of mercy, those who endeavour to recommend themselves to his notice, and in an unfeigned humility of heart think themselves unworthy that he should be mindful of them.



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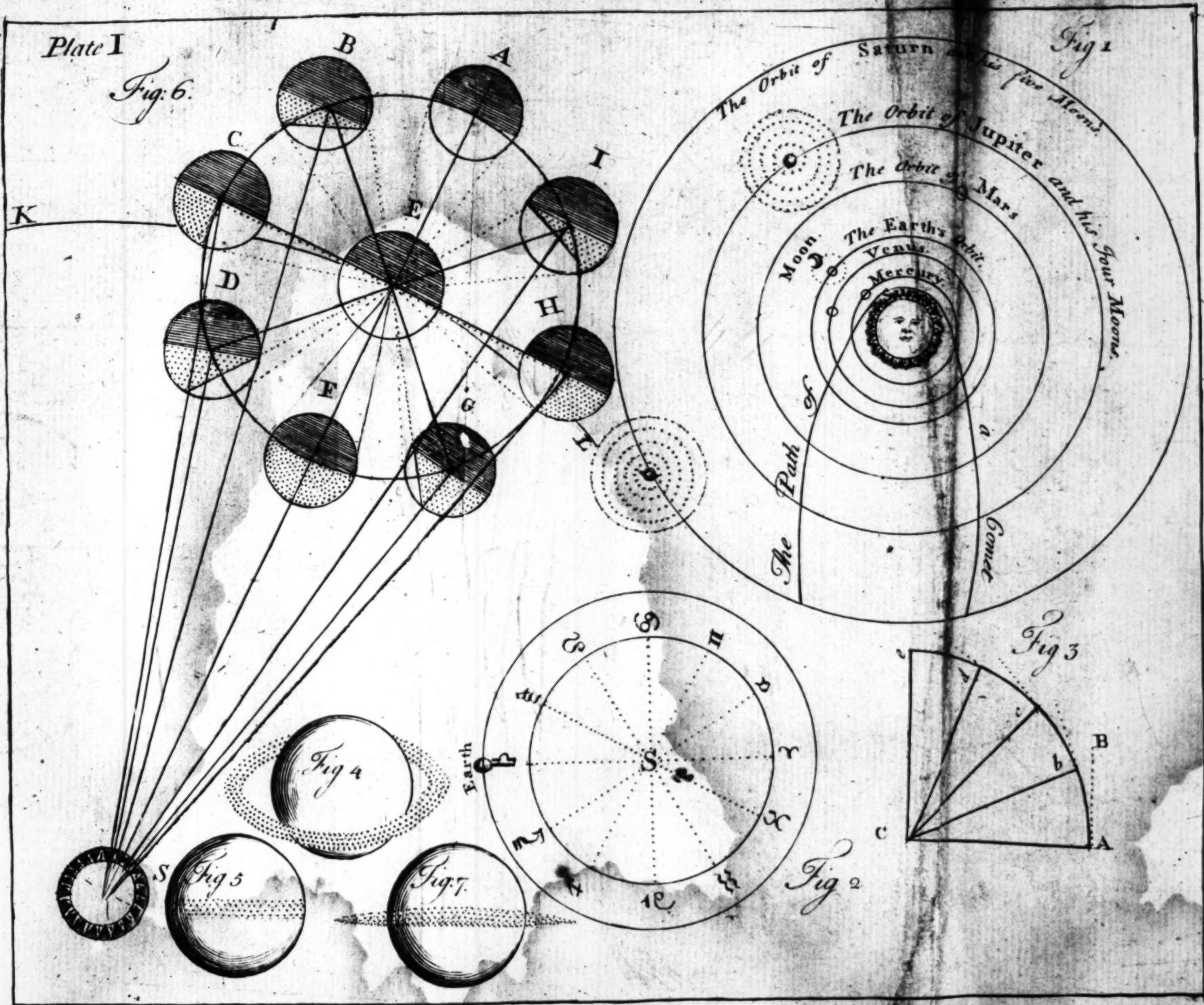


Plate II.

